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THE CHICAGO ACADEMY OF SCIENCES
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The
Paleontology of the Niagaran Limestone
in the Chicago Area

THE CRINOIDEA

BY

STUART WELLER

OF THE UNIVERSITY OF CHICAGO

BULLETIN No. IV.

PART I.

OF

THE NATURAL HISTORY SURVEY

ISSUED JUNE 27, 1900

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LETTER OF TRANSMITTAL.

CHICAGO, ILL., May 11, 1900.

DEAR SIR:

By direction of the Board of Managers of The Natural History Survey of The Chicago Academy of Sciences, I herewith submit to you for publication a report on The Crinoidea, to be issued, under the rules of the Academy governing such matters, as Part I of Bulletin No. IV, on The Paleontology of the Niagaran Limestone in the Chicago Area, prepared by Stuart Weller of the University of Chicago.

Respectfully,

WILLIAM K. HIGLEY,
Chairman.

To THOMAS C. CHAMBERLIN,
President of The Chicago Academy of Sciences.

The Board of Managers of The Natural History Survey of
The Chicago Academy of Sciences:

WILLIAM K. HIGLEY, Chairman.

CHARLES S. RADDIN, Secretary.

THOMAS C. CHAMBERLIN.

GAYTON A. DOUGLASS.

THOMAS T. JOHNSTON.

THE NATURAL HISTORY SURVEY.

The report on the paleontology of the area covered by The Natural History Survey, will be issued in parts, prepared by Mr. Stuart Weller, of the University of Chicago, and will constitute Bulletin No. IV.

The first part, on the Crinoidea, will be followed by the others as soon as the necessary material can be studied.

This report is of special interest and importance, as the researches of the writer have enabled him to describe one new genus and twenty-seven new species. The genus has been named *Chicagocrinus* in honor of the city of Chicago. The illustrations were prepared by Mr. Weller, and are worthy of especial notice. These, together with the text, will furnish a manual on the subject for the use of students in local investigations.

The territory covered by the survey includes Cook and DuPage counties and the nine north townships of Will County, in Illinois, with a portion of Lake County, Indiana. This gives an area of about forty-eight or fifty miles square, or a land surface of nearly 1,800 square miles.

While the fossil bearing strata are not generally exposed in this district, such localities as offer opportunities for research are rich in the number and variety of specimens.

Besides the material collected and studied in the institutions mentioned by Mr. Weller, the present work is essentially based on the Egan collection of The Chicago Academy of Sciences. This valuable collection of fossils consists of over 12,000 specimens, representing something more than 1,600 species; 4,000 specimens of these, including a large number of species, are from Chicago.

The board of managers desires to acknowledge its obligation to the University of Chicago, the Field Columbian Museum, the Northwestern University, as well as to the individuals whose courtesy to Mr. Weller greatly facilitated the work of preparing this report. Especial mention should be made of the generosity of our patron, Mr. George H. Laffin, whose continued interest in the work of the Academy has made it possible to issue the present publication.

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PREFACE.

The fauna of the Niagaran limestone at Chicago has long attracted attention. The pioneer collector of the now famous Bridgeport fossils was the late Dr. Oliver Marcy, of the Northwestern University. In 1865, in conjunction with Dr. Alexander Winchell, he published a list of the species identified, with descriptions of several new ones. At about the same time Dr. James Hall described some Bridgeport fossils along with others from southeastern Wisconsin of about the same horizon. After the publications of Winchell and Marcy and James Hall, little or nothing was published upon the Chicago fossils until the years 1880 to 1882, when, in several papers, Mr. S. A. Miller described a number of species, particularly of the grínoids. Since that time Chicago fossils have been mentioned in various publications.

Although but comparatively little has been published upon the Chicago fossils, and although what has been published is for the most part inaccessible to the average collector, the local collectors of Chicago fossils have not been idle, and several important private collections have been made. One of the most complete of these has been collected by Mr. W. C. Egan, and the Egan Collection, rich in excellent material, forms the basis of the local collection of fossils in the museum of The Chicago Academy of Sciences, and is also the basis of the present publication. The type specimens of the species described by Mr. S. A. Miller are all included in the Egan Collection. Aside from the collection in the museum of the Academy of Sciences, the collections in Walker Museum of the University of Chicago, in the Field Columbian Museum, and in the museum of Northwestern University at Evanston, where Winchell and Marcy's types are preserved, have afforded much material of value in the preparation of this bulletin. Of the private collections which have been placed at the disposal of the writer that of Mr. H. H. Hindshaw needs special mention. Mr. W. R. Head and Mr. H. B. Derr have also given free use of their collections of Chicago fossils. Since the excavation of the Chicago Drainage Canal has been under way new opportunities for the collection of the Niagaran fossils of northeastern Illinois have been offered. For valuable material from

this excavation at Romeo and Lemont, the writer is under obligation to Messrs. J. H. Ferriss and J. H. Handwerk of Joliet, and Mr. L. H. Hyde, formerly of Joliet but now of Pipestone, Minn. To all these collectors, and to Dr. Oliver Marcy of the Northwestern University, and Dr. O. C. Farrington of the Field Columbian Museum, acknowledgment is due for the generosity with which they have placed their valuable collections in the hands of the writer. In addition acknowledgment is due Mr. E. E. Teller of Milwaukee, Wis. Although southern Wisconsin is not included in the survey district of the Chicago Academy, the fauna of the Niagaran limestone in that region is largely identical with that at Chicago, and Mr. Teller has placed at the disposal of the writer material from his large collection, which has been invaluable in clearing up some doubtful points in the structure of some genera, particularly in the case of *Callicrinus*.

The age of the strata which contain the Chicago fauna is late Niagaran, but little older than the Guelph formation of Canada. The formation in which the fossils are preserved is a dolomite, and the manner of preservation of the fossils is by no means so satisfactory as would be desirable. For the most part they are internal casts and external impressions; in only rare instances are the fossils themselves found preserved with any degree of perfection. For this reason it is not always practicable to make proper comparisons between Chicago species and the same or allied species preserved in other localities under different conditions. In certain cases very excellent reproductions of the external characters of some species have been secured by making wax casts from the natural moulds in the rock, and by the use of these casts, and such specimens as have been secured preserving the substance of the fossils, the characters, in many instances, have been made out with some degree of completeness. Some species, however, have not as yet afforded good specimens either of external moulds or of the substance of the fossil itself.

In the present number of the bulletin, aside from the geologic introduction, the crinoids alone are described. In future numbers it is intended to consider the remaining classes of organisms represented in the fauna. The crinoidal element of the fauna, however, is of great interest for several reasons. In the first place, the Niagaran limestone of the Chicago region, including southeastern Wisconsin where the fauna is

essentially the same, contains, next to the Island of Gotland in the southern part of the Baltic Sea, a larger number of species of crinoids of this horizon than any similar region in the world, so far as is known at the present time. There are recognized altogether 382 species of Silurian crinoids, and of these 68, or about eighteen per cent., occur in the Chicago area. In Gotland 172 species are recognized, but these are not all associated in the same stratum and should perhaps be divided into several faunal groups. In the state of Indiana 60 species have been recognized, but most of these come from two localities, Waldron with 26 species, and St. Paul with 24 species, from two distinct formations, or strata, in which the faunas are quite different. In the Niagaran formations of New York state 43 species are known, and in England 35 species.

Aside from the large number of species of crinoids in the Chicago fauna the geographic distribution of some of them is of peculiar interest. Several genera, heretofore known only from Gotland, or from Gotland and England, are now found for the first time in America. The members of the family *Calyptocrinidae* seem to have the Chicago region as their metropolis, as their center of maximum differentiation. The typical genus, *Eucalyptocrinus*, is represented by 11 species, and the genus *Callicrinus* apparently has its most extravagant development here, one species having the terminal plates of the anal tube expanded into a great umbrella-like disk. Aside from these two genera, already known in different parts of the world, a third, to which the name *Chicagocrinus* has been given, is here described for the first time.

One of the most remarkable features of the Chicago crinoid fauna, when compared with that of Gotland, is the comparatively small number of inadunate crinoids, only six species being recognized in the Chicago fauna against 40 in Gotland.

Further collections will, without doubt, add to our present list of crinoids, and it is possible that some private collections not seen by the writer may exist, in which new material is present. A number of additional species have already been observed, of which the specimens available are insufficient for description. To any persons who may possess additional crinoidal material from this fauna, or material which will be of value in the preparation of the additional parts of this bulletin, the writer will be under obligations for information received or for specimens loaned.

GEOLOGIC INTRODUCTION.*

The oceanic movements which brought the Ordovician period to a close are believed to have been such as to affect all continents in a similar manner. The transition period from Ordovician to Silurian was probably characterized by a special shrinkage of the earth, due to an effort at adjustment to the stresses that had been accumulating during the whole Cambrian and Ordovician time. In this shrinking process it is assumed that the ocean basins were made deeper and their capacity increased, so that the waters of the shallow seas, lying upon the borders of the continents and reaching into the interior to some notable extent, were drawn off, and the bottoms of these seas became a part of the dry land. It is assumed that the continental shore-lines migrated oceanward until they no longer lay upon the continental platforms themselves, but upon their abysmal slopes, and the former broad, shallow water tracts of the sea shelves were reduced to narrow bands. With the destruction of these shallow seas upon the continental platforms, the multitude of shallow water organisms which had existed in them were largely forced into extinction.†

After the readjustment of the solid earth, the seas began again to creep gradually upon the continental platforms by reason of the landward cutting of the sea-cliffs, because of the sediments carried down from the land and dumped into the ocean basins, and owing to the gradual settling back of those portions of the crust which had been locally forced upward beyond isostatic equilibrium. With the continuation of these processes new sea-shelves and new epicontinental seas came into existence, and grew in extent as the period advanced. These were the Silurian seas, and in them there evolved a new assemblage of shallow water organisms, the Silurian fauna. This fauna was derived genetically from those remnants of the earlier Ordovician fauna which had happened to survive in favored localities; but with the very general increase of the

* The substance of this Geologic Introduction was published in *Jour. Geol.*, Vol. VI, pp. 692-703.

† For a fuller exposition of this hypothesis see "The Ulterior Basis of Time Divisions and the Classification of Geologic History," by T. C. Chamberlin, *Jour. Geol.*, Vol. VI, p. 449.

shallow waters a great expansional evolution took place, and many organic characteristics, showing a notable advance in differentiation beyond that of Ordovician time, came into existence and were characteristic of Silurian time.*

As the Ordovician waters were gradually drawn off from the continental platform, the once broad sea, extending from eastern Canada to beyond the present Rocky Mountains, with its wealth of organic life, was slowly contracted, and its life either gradually became extinct or was forced into modified forms or compelled to emigrate under unfavorable conditions. The remains of the last survivors within the area of this once magnificent fauna are now found in the lower beds of the Medina formation in Virginia.† With the passing of these survivors the interior Medina basin became a lifeless tract so far as any evidence has been left to us, save for some low types of aquatic plants and a few worm burrows. It was probably an isolated basin.

With the encroachment of the Silurian sea upon the continent, a junction was at last effected with the Medina basin, and again marine conditions and a marine fauna occupied the area. The Medina fauna of New York,‡ which has been described from the upper beds of the formation, signals the return of the marine conditions. This fauna is a meager one, containing but thirteen species, most of which would not be out of place in either an Ordovician or a Silurian fauna, but the presence of a species of the brachiopod genus *Whitfieldella* stamps the fauna as of Silurian age.

In the New York section, which is usually taken as the standard for our continent, the Medina formation constitutes the lowest division of the Silurian system. The Clinton division, following the Medina, consists in New York of a series of strata diverse in character. There are beds of shale, sandstone and limestone, and one very persistent stratum is the fossil iron ore bed. This division was well named "Protean Group" by the early New York geologists. The characters of the strata are precisely such as one would expect to find in a series of beds deposited during a period of readjustment of local conditions.

The Niagara division of the Silurian, following the Clinton,

*See "A Systematic Source of Evolution of Provincial Faunas," by T. C. Chamberlin, Jour. Geol., Vol. VI, p. 597.

†Stevenson, Proc. Am. Phil. Soc., Vol. XXII, pp. 142 and 150; Vol. XXIV, pp. 85, 87, and 94.

‡Pal. N. Y., Vol. II, pp. 4-14.

essentially represents the period when local conditions had become readjusted and equilibrium established. It was primarily a limestone-forming period, and although the Niagara shales of New York are classed with the limestone, it would perhaps be more natural from a stratigraphic point of view to place them in the preceding division.

From the point of view here taken, it will be seen that the Clinton and Niagara cannot be considered as separate and distinct time divisions, having the same significance throughout the entire area in America which was originally covered by Silurian waters. The two divisions, rather, exemplify two sets of conditions. In the Mississippi Valley the Clinton period of readjustment was short, and is represented by a very thin series of sediments. The conditions of equilibrium with clear limestone-depositing seas very soon became established after the incursion of the Silurian waters, but in New York, in the region nearer the finally-established shore line, this period of readjustment occupied a much longer time. In the southern Appalachian region the Niagara conditions seem never to have been attained. Indeed, since it was probably the last region reached by the encroaching sea, it is possible that even the Clinton conditions did not begin there until long after the Niagara conditions had become established in some other parts of the continent. Taken in a time sense, the Clinton and Niagara divisions of the Silurian must be considered as a unit, the stratigraphic distinctions between the two being of but local significance.

In like manner the Clinton and Niagara faunas must be considered as a unit. To be sure there are species which in any given area are known only in the Clinton strata, and others which are restricted to the Niagara limestone; there are also species restricted to a single stratum of either one division or the other. From the very nature of the case this would be expected, because all organisms are not so constituted as to be able to adjust themselves to all conditions of environment. There are always sure to be local adaptations in any general fauna to the varying local conditions both in time and space. And so we must look upon the general Silurian fauna of America not as constituted of two sharply defined faunal divisions, the Clinton and the Niagara, but as being one composite faunal unit composed of numerous faunulæ, adjusted to a great variety of local environments.

The same general Silurian fauna which occupied so large a portion of the North American continent was also present in other parts of the world. In Europe it is recognized with its local adaptations in England, in the Island of Gotland, in Russia, in Bohemia, and elsewhere. Many species are common to the Silurian beds of England and North America, and there are like relations between the faunas in America and other parts of Europe. In other parts of the world this same general fauna has been found. As far away as New Zealand* a Silurian fauna has been studied in which there are several species common to Europe and North America. The Silurian fauna described by de Koninck† from New South Wales, Australia, contains 59 species, and of these 47 are identified with European species, many of them also being recognized in the Silurian fauna of North America. These facts show that there must have been free intercommunication between the Silurian seas of different parts of the world, and means of intermigration for the organisms which inhabited them.

Although it has long been recognized that some means of intercommunication between Europe and the interior of North America must have existed during Silurian time, the pathway connecting the two regions has never been definitely located. During Ordovician time there was an open passageway through the St Lawrence Valley, joining the interior epicontinental sea with the ancient Atlantic Ocean, but during the Ordovico-Silurian transition period the Taconic range of mountains was elevated, and this passage entirely closed. The Appalachian land was the eastern barrier to the interior Silurian sea, and during the period this land was joined to the Laurentian land at the north. East of this land barrier the Silurian fauna occurs in the eastern provinces of Canada, but these eastern strata are not continuous with those in New York, and the communication between the two regions was not direct.

In a southern direction the Silurian strata thin out and become more clastic in constitution, indicating proximity to a shore line, and it is probable that even at this early period the western extension of the Appalachian land, described by Griswold‡ and Branner, was already in existence.

The western extension of Silurian strata cannot be defi-

*Quart. Jour. Geol. Soc., Lond., Vol. XLI, p. 199 (1885).

†Mem. de la Soc. Roy. des. Sci. de Liege, 2d Ser., Vol. VI (1876), and translated in Mem. Geol. Surv., N. S. Wales. Palæontology No. 6 (1898).

‡Proc. Bost. Soc. Nat. Hist., Vol. XXVI, p. 474.

Am. Jour. Sci. (4), Vol. IV, p. 357.

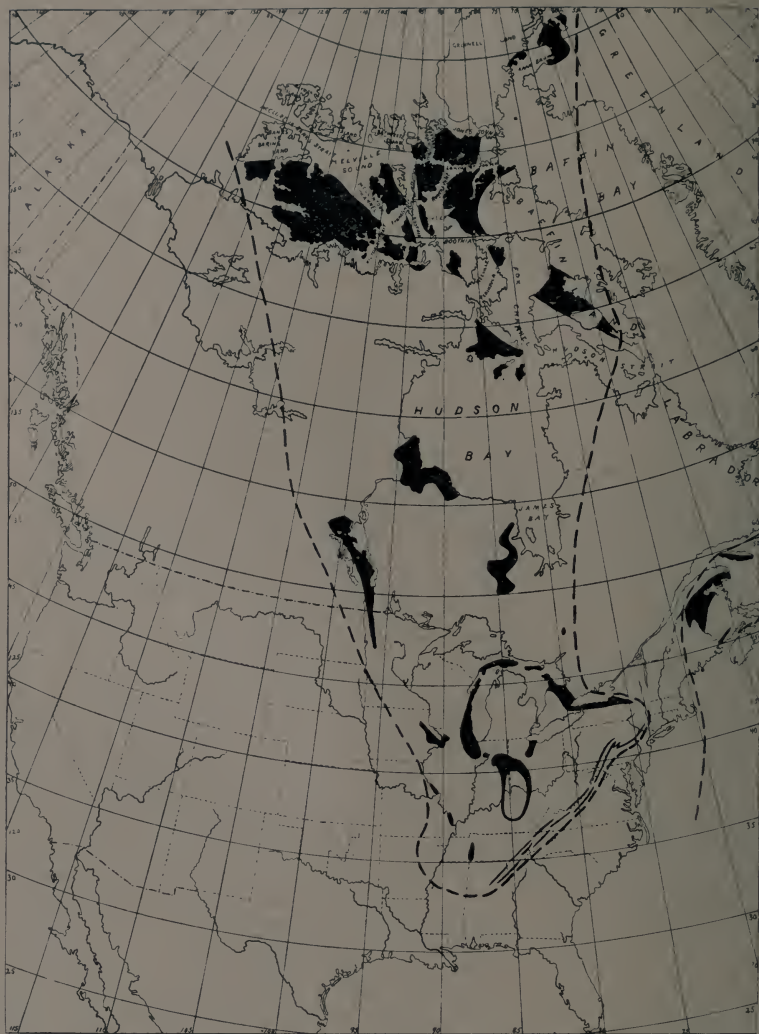


FIG. 1.—Map showing the distribution of Silurian outcrops in North America, with the hypothetical Silurian shore lines.

nately shown, but they are nowhere a conspicuous feature in the United States further west than Iowa. Beds in the far west containing the chain coral, *Halysites*, have been referred to this period, but usually upon insufficient evidence, for this genus is known also to occur in the Ordovician. In those rare instances where other forms have been found associated with the chain coral, they usually have been of an Ordovician rather than a Silurian facies. Nowhere in the great western region has the wonderfully prolific Silurian fauna of the east been found, and it is safe to assume that the greater part of this region was above sea level during Silurian time.

This leaves the north as the only available outlet for the interior Silurian epicontinental sea. A glance at the accompanying map, showing the distribution of the Silurian outcrops in North America, shows their northward extension. There is an extensive area in the region of Lake Winnipeg, one near James Bay, and another along the western shore of Hudson Bay. In all these regions the general Silurian fauna of America and Europe has been identified. The strata lie directly upon precambrian crystalline rocks, or upon Ordovician strata; and as they could not have been deposited in these isolated patches they must represent the remnants of a Silurian sheet which was at one time continuous, and covered the entire intermediate region. Silurian strata have been recognized still further north, on the islands at the mouth of Hudson Bay, and on the islands and mainland round about the Gulf of Boothia west of the Boothia peninsula. In these two latter regions Silurian fossils have been found in abundance by several of the Arctic expeditions. From this general area Dawson* gives a list of 13 localities from which Silurian fossils have been collected. If the region could be visited and properly studied a prolific fauna would doubtless be secured. West of McClintock Channel the Silurian has not been properly differentiated from the Devonian, and Silurian fossils have not yet been found. In northern Greenland and in Grinnell Land Silurian strata with their characteristic fauna are known to exist.

Turning now to the map of the north polar regions, it will be seen that the distance between northern Greenland and northern Russia, where the Silurian fauna is known, is not extreme. Spitzbergen lies at a point nearly midway between these regions, and the shores of these islands are known to con-

*Ann. Rep. Geol. Surv., Canada, New Series, Vol. II, p. 45 R. (1887).

sist for the most part of Paleozoic strata. Although no Silurian rocks have yet been recorded from the islands, the presence of the Paleozoic strata is a connecting link across this little known Arctic region. In western Russia the Silurian strata are not exposed, but the area colored is occupied by Paleozoic strata of younger age than the Silurian, and is probably underlain by the Silurian. The area in Russia between the two regions colored is occupied by Mesozoic strata, and the Paleozoic beds, with the Silurian among them, doubtless un-



FIG. 2.—Map of the North Polar regions, showing distribution of Silurian strata in North America and northern Europe, with the hypothetical Silurian shore lines.

derlie the whole region. The Island of Gotland in the Baltic is constituted entirely of Silurian rocks, and one of the most prolific Silurian faunas known to exist in so small an area has been described from this locality.

The distributional evidence of the Silurian strata and fauna favorable to the existence of a north polar connection between the Silurian seas of Europe and those of the interior of North America having been pointed out, turn to the evidence of such a connection which may be afforded by the life of the period.

A study of the Silurian faunas in the Mississippi Valley shows some remarkable points of resemblance with the faunas of northern Europe, which are lacking in a comparison of the New York and the European Silurian faunas.

In the fauna of this age at Chicago, and in northern Illinois, some remarkable forms of crinoids have been recognized which have not hitherto been recorded from America. One of these is *Crotalocrinus* (Fig. 3), one of the most highly specialized genera of crinoids that has ever been described. Its arms, instead of being simply branched, as is usually the case,



FIG. 3.



FIG. 4.



FIG. 5.

A group of fossil organisms peculiar to the interior of North America and northern Europe. Fig. 3, *Crotalocrinus pulcher* His. (after Wachsmuth and Springer). Fig. 4, *Petalocrinus mirabilis*, Weller. Fig. 5, *Goniophyllum pyramidale* His. (after Lindström).

have the subdivisions joined laterally in such a manner as to form great flat, flexible extensions from the body. It has been found most abundantly upon the Island of Gotland, but it also occurs at Dudley, England, and is now found in the Chicago fauna. Two genera, *Corymbocrinus* (Fig. 15, page 31) and *Pycnosaccus*, founded upon Gotland specimens, are now found

for the first time in America in the Chicago fauna. Both of these also occur in England.

Petalocrinus (Fig. 4) is another highly specialized crinoid genus, with the arm branches from each ray consolidated into a triangular plate or "arm fan," so that the creature with its arms extended closely resembles the corolla of a flower with five petals. This peculiar genus was first described by Weller* from Iowa, and later a specimen was found from Indiana. The genus is now known to occur in Gotland, and several species have been described from there by Bather.†

Turning to the corals we find that the peculiar and highly specialized genus, *Goniophyllum* (Fig. 5), a quadrangular cup coral with an operculum of four triangular plates, is found in England, Gotland, and Iowa,‡ but is recognized nowhere else. The peculiar little twisted brachiopod, *Streptis*, reported from England and the continent of Europe, has more recently been recorded from the Silurian near Batesville, Ark.¶

The presence of all these peculiar and highly specialized forms in various localities in the Mississippi Valley and in Europe, and their entire absence from New York, where the fauna has really been more carefully studied than in any other part of America, is, to say the least, suggestive. If there had been a direct east and west pathway of communication between Europe and the interior of North America, why have not some of these forms also been found in New York, an intermediate locality which would have been in the direct path?

Only a few of the more remarkable forms common to the Mississippi Valley and northern Europe, but absent from New York, have been mentioned. There are many others in various classes of a more modest and ordinary appearance which need not be specifically mentioned here. The trilobites of the Chicago fauna, however, when properly studied, bid fair to bring out fully as remarkable points of relationship between the two faunas as the forms already mentioned.

The facts of the distribution of the life indicate clearly that northern Europe was more closely associated with the Mississippi Valley than with the New York region in Silurian time. The sea-shelf connection must have been in either a southern, western, or northern direction from the interior of

* Jour. Geol., Vol. IV, p. 167.

† Quart. Jour. Geol. Soc., Lond., Vol. LIV., p. 401.

‡ Jour. Geol., Vol. IV., p. 170.

¶ Am. Jour. Sci. [3], Vol. XLVIII, p. 329.

America. If it is shown that the Appalachian land extended westward across the southern part of the United States in Silurian time, the southern route is barred; but if that land was not present, the pathway of intermigration would have been around the southern end of Appalachia, and then north along its eastern shore and across to Europe. According to the mode of interpretation here adopted it should have been, under these circumstances, along the sea-shelf of the North Atlantic, except as the species were adapted to pelagic migration; and as the Silurian strata in the eastern provinces of Canada lie in this path, some of the peculiar forms mentioned might be looked for in their fauna, but all these species or related species are entirely absent so far as known. However, the stratigraphic evidence seems to shut off this southern route, because the Silurian strata grow thin in this direction and become more clastic, exhibiting every evidence of having been deposited near a shore line.

The western route need not be considered, because the Silurian fauna is not known to have any notable development in that direction. This leaves only the northern route. The presence in the Arctic localities of some of the peculiar genera already mentioned would furnish the most substantial evidence in favor of this route. The conditions under which fossils have been collected in the Arctic regions have been such, however, that the fossil faunas of the far north are but poorly known. Although this is the fact, the genus *Crotalocrinus* has been identified from a small island in Wellington Channel* from specimens of the stem alone. The stem of this genus, however, is quite distinctive, and the identification is probably correct. The other forms mentioned have not yet been found there, but they probably will be if the proper opportunity for the study of those faunas is ever offered.

If the interpretation here offered be the correct one, then the usual conception of the Silurian geography of North America must be somewhat altered. We must conceive of a North Polar sea with a great tongue stretching southward through Hudson Bay to about latitude 33° . There were doubtless islands standing above sea level within this great epicontinental sea, and at the latitude of New York there was a bay reaching to the eastward, in which the Silurian sediments of the New York system were deposited. Labrador, Greenland, and

*Quart. Jour. Geol. Soc., Lond., Vol. IX, p. 315 (1853).

Scandinavia were in a measure joined into one great land area, though perhaps with its continuity broken, with a sea-shelf lying to the north of it and another to the south. Another epicontinental tongue of this northern sea extended south into Europe, bending to the west around the southern part of the Scandinavian land and connecting with a Silurian Atlantic ocean. The sea-shelf to the north of the Labrador-Scandinavian land was a means of intercommunication between northern Europe and the interior of North America, and the sea-shelf to the south of this land was a pathway between England and eastern Canada. Other tongues reaching to the south were probably present through Asia and through the Pacific Ocean, the New Zealand and Australian communication coming through one of these.

MORPHOLOGY OF THE CRINOIDEA.

The branch Echinodermata of the animal kingdom contains the seven classes: *Crinoidea* (sea lilies), *Cystoidea*, *Blastoidea*, *Asteroidea* (star-fishes), *Ophiuroidea* (serpent-stars or brittle-stars), *Echinoidea* (sea-urchins), and *Holothuroidea* (sea-cucumbers). The first three of these constitute the sub-branch *Pelmatozoa*, and are distinguished from all the others in having the oral, or mouth side, uppermost when the animal is in its normal position, and in the possession of a stem attached to the side of the body opposite the mouth, by means of which the animal may be fixed to extraneous objects at some period of its life. Among the crinoids the stem is in most cases persistent during the entire life of the individual, and the animal may be securely attached during its whole existence, or it may have the power of breaking away and moving to a new point of attachment. In a few genera the stem is discarded in the adult and the animal becomes a free moving creature.

The bodies of the *Pelmatozoa* are covered by calcareous plates, either regularly or irregularly arranged, and have a circlet of simple or branching arms, or some structures that correspond to arms, surrounding the mouth. The arms are either entirely free from the body, or they are represented by ambulacra, which may be considered as arms attached to the body by their dorsal side throughout their entire length.

The *Crinoidea* are characterized by their more or less perfectly pentamerous radiate symmetry, by the definite plan of arrangement of the plates of the body, and by the five simple or branching arms which are free throughout the whole or the greater part of their length.

A complete crinoid consists essentially of two parts: (1) the *crown*, which is constituted of the body, or *calyx*, and the *arms*, and (2) the *stem* or *column*, by means of which the crown is attached. The lower or distal end of the stem is usually differentiated in some manner, in order to provide for the attachment, either by branching more or less irregularly to form a root-like attachment, or by expanding into a disk-like body.

Figure 6 is an illustration of a complete fossil crinoid from the Silurian shale at Waldron, Ind. In the lower part of the figure may be seen the roots which, during the life of the creature, were imbedded in the mud of the sea bottom, now turned into shale. The jointed stem may also be seen and at the summit the crown. The general aspect of the animal is that of a plant, hence the popular name sea-lily. Although the creature was attached during life, when its habits of life are taken into account it will be recognized that this attachment was really but a means of motion relative to the medium in which it lived. The food of crinoids consists now, and doubtless in former times also, of the minute organisms floating in the water. This food is conveyed to the mouth by currents of water, which are made to pass along the grooves upon the ventral sides of the arms by the constant movement of cilia, with which the grooves are lined. The food of the crinoids, floating free in the water, is carried here and there by the currents, therefore, by becoming fixed to the ocean bottom, the crinoids have an abundance of food brought to them. On the other hand, if the crinoids were not stationary they too would float with the currents, and their food supply would be greatly diminished.

The crinoidal stem or column is constituted of a large number of flat, disk-like, calcareous plates, *stem ossicles*, or *stem joints*, either circular, pentagonal, elliptical, stellate, semilunate, or quadrangular in form, pierced in the center by a round, pentangular, or pentalobate opening. These disks are arranged serially in the column, the perforation through their centers forming the *axial canal*. In the living animal adjacent plates are separated by a thin layer of tissue, so that the whole stem is more or less flexible, and the axial canal contains vessels of the circulatory system which carry nutriment to this tissue. The roots are nothing more than branches of the stem, and likewise consist of disks arranged serially with axial canals. In many cases all the disks of the column are not of equal diameter or thickness. The larger, or *nodal joints*, may be arranged alternately with the smaller, or *internodals*, or there may be several of the internodals between successive nodals. The projecting edges of the nodal joints are often ornamented in various ways by crenulations, spines, or nodes, and sometimes they bear branches or cirri at irregular intervals, or throughout the whole length of the stem.

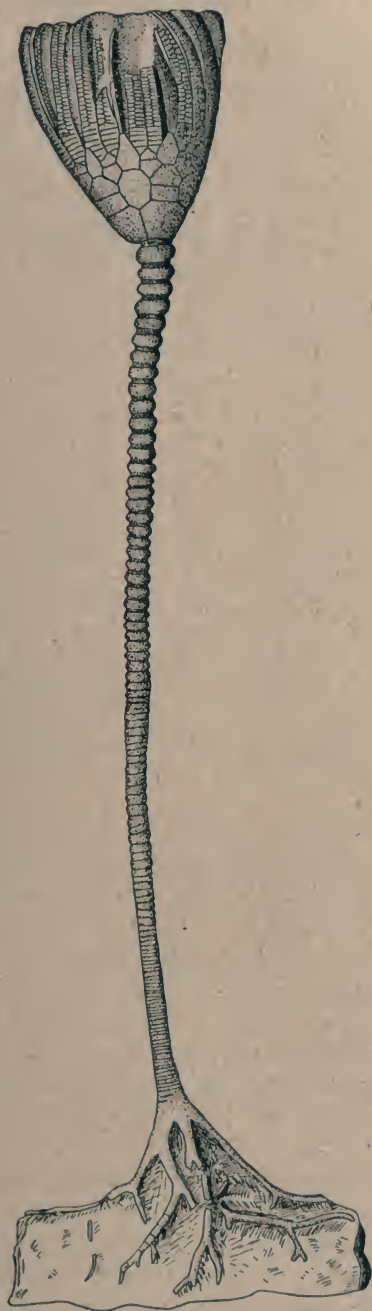


FIG. 6.—*Eucalyptocrinus crassus* H. (after Hall). A complete crinoid from Waldron, Ind., showing root, stem, and crown.

The young stem joints appear between the topmost joint and the body of the crinoid, or at a short distance below this point. The nodal joints are always introduced just below the calyx, the internodals being introduced between the nodals in the proximal portion of the stem. From this method of growth it is apparent that the stem matures from the root upward, that portion nearest the body always being the youngest.

The constituent plates of the body or *calyx* of the crinoid may be conveniently divided into four groups: (1) the *base*, (2) the *rays*, (3) the *oral pyramid*, and (4) the *interrays*. The first three of these groups constitute the primary plates of the calyx, so called because they are the first parts developed in the young crinoid, and are represented in every group of the class, and undergo comparatively few modifications in geologic time. The plates of the interrays are the supplementary plates, so-called because they appear in the growing crinoid but are unrepresented in the more primitive families. When present they are interposed between the primary plates, and help to increase the capacity of the visceral cavity. They are very important in classification, offering by their presence or absence, their position and distribution in the calyx, their arrangement and multiplication, excellent criteria for taxonomic divisions.

All those plates of the calyx situated between the bases of the arms and the columnar facet constitute the *dorsal cup*. All the plates above the bases of the arms constitute the *ventral disk*, the *vault* or the *tegmen*. The plates of the base, and those of the rays which are not free, are always included in the dorsal cup. The plates of the oral pyramid are always in the ventral disk, and the plates of the interrays are distributed partly in the dorsal cup and partly in the ventral disk.

The development of the calcareous plates has been carefully observed in one of the recent crinoids, *Antedon*, shown in figures 7 and 8. Figure 7 represents the free swimming larva of this crinoid very much magnified, with its tufts and rings of cilia. In it may be seen two circles of rudimentary plates, the lower of which eventually develops into the basals and the upper into the orals. The rudimentary column, with the disk by which it is finally attached, may also be seen. Figure 8 is a later attached stage of the same animal. The same features as those represented in figure 7 may be seen, with the excep-

tion of the cilia, but in addition there has been introduced a third row of smaller plates between the two earlier rings, and alternate with them. These are the rudimentary radials which in the adult crinoid support all the plates of the rays and the arms.

The *base* of a crinoid may consist of one or two circles or rows of plates. In the former case it is said to be *monocyclic*, and in the latter *dicyclic*. Normally there are five plates in each circle, but in the lowest row, whether the base be monocyclic or dicyclic, two or more of the plates may be consolidated so



FIG. 7

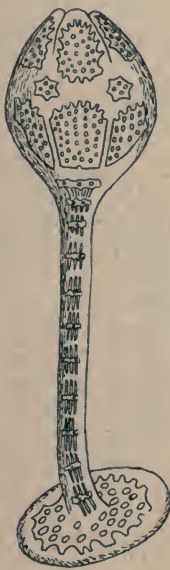


FIG. 8.

Figs. 7 and 8.--Larval stages of *Antedon*, enlarged (after Sir Wyville Thompson).

that the row may consist of four, three, or even of but two plates. In the dicyclic base the plates of the two rows alternate in position, and the plates of the succeeding circle, which are the first plates of the rays, alternate with the upper row of plates in the base. This arrangement of the plates is excellently shown in figure 9. This is a very simple crinoid whose dorsal cup consists entirely of three circles of plates alternating in position. The plates of the upper circle, it will be seen, are extended upward in a series of smaller plates which form the arms, and are therefore the beginnings of the rays. The

two lower circles constitute the base. The lowest plates are the *infrabasals*, and correspond in the direction of their median lines with the rays, and are therefore radial in position. The second row are the basals, and are interradiar in position. Figure 10 is a good illustration of a monocyclic crinoid. In this, it will be observed, the base consists of a single circle of plates which are interradiar in position, corresponding with the second rather than the first circle of plates in figure 9. In the monocyclic base, therefore, *the infrabasals are absent*, only the basals, the plates interradiar in position, being represented.

Figures 11 and 12 show the same thing in a diagrammatic manner. These are diagrams of the same two crinoids illustrated above, the plates of their dorsal cups being separated and spread out as upon a flat surface, the center of the columnar facets being the center of the diagrams. In this manner

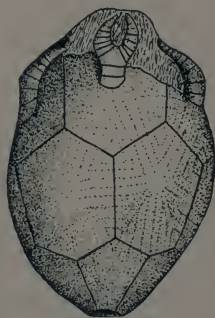


FIG. 9.



FIG. 10.

FIG. 9.—*Carabocrinus vancortlandti* (after Billings). A dicyclic crinoid.

FIG. 10.—*Platycrinus planus* (after Wachsmuth and Springer). A monocyclic crinoid.

the forms and relative positions of all the plates in the dorsal cup of any crinoid may be easily shown, and such diagrams will be often used in the following pages. In figure 11, illustrating the dicyclic base, it will be observed that the inner circle of plates, the *infrabasals*, marked *ib*, have their median lines coincident with the median lines of the radials, those marked *R*, therefore they are radial in position. The second circle, marked *B*, are the basals, and are interradiar in position. Turning now to figure 12 it will at once be recognized that but a single circle of plates are present within the radial circle. This circle consists of but three plates, but two of these are

larger than the third, and really represent two plates each, as is indicated by the dotted lines. If these be considered as five separate plates, it will be seen at once that their position is interradial, and therefore that they correspond not to the innermost circle of plates in figure 11, but to the second circle. Therefore in figure 12 the innermost circle of plates, the infrabasals seen in figure 11, are absent, and the base consists of but a single circle of plates, the basals, and is monocyclic.

The lowermost circle of plates in the base, whether they be basals or infrabasals, bears a circular *columnar facet*, where the column is attached, pierced at the center by the axial canal of the column. In the dicyclic base, when the infrabasals



FIG. 11.

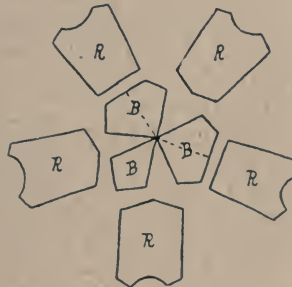


FIG. 12.

FIG. 11.—Diagram of the plates in the dorsal cup of a dicyclic crinoid.

FIG. 12.—Diagram of the plates in the dorsal cup of a monocyclic crinoid.

are small, the columnar facet sometimes entirely covers the infrabasal ring, and extends out upon the basals, in which case the infrabasals can only be observed when the topmost stem joint is detached.

The rays of the crinoid, following the basal plates and alternating with them, are invariably five in number, and consist either of a simple or a bifurcating series of plates. The first plate of each ray is always incorporated in the dorsal cup of the calyx, and these five plates are called the *radials*. In some of the lower crinoids one or more of the radials may be divided into two plates by a transverse suture. These two

plates, however, really represent the single radial plate, and when it is so divided the radial is said to be compound. The simple or bifurcating series of plates supported by the radials are called *brachials*, and these may be either entirely free from the calyx, or they may be included in the sides of the dorsal cup for a greater or less distance before becoming free. As soon as the brachial plates do become free they constitute the arms. In those crinoids whose rays consist of a bifurcating series of plates, the brachial plates are of different orders. The plates between the radials and the first bifurcation are the brachials of the first order, and are called *costals*. Above the first bifurcation there are of course two series of brachial plates of the second order; these are called *distichals*. Above the second bifurcations are four series of brachial plates of the third order, or *palmars*. Above the palmars there may be numerous bifurcations, and numerous orders of brachial plates. All of these are called *post-palmars*, it rarely being necessary to refer specifically to any of them; but whenever it does become necessary they are simply called post-palmars of the first, second, or third order, whichever they may happen to be. The number of plates in each order of brachials varies greatly among different genera and species of crinoids, and oftentimes the branching of the rays is irregular, so that the number of distichals, palmars, or post-palmars may vary in the different series in the same ray or in different rays of the same individual.

Figures 13, 14, and 15 are introduced to illustrate the characters of the rays just described. Figure 13 is a very simple crinoid in which the rays consist of simple series of plates. In both the other figures the rays consist of bifurcating series. In figure 14 all the brachial plates are free from the calyx, while in figure 15 the lower ones are incorporated in the dorsal cup.

In each order of brachials the bifurcating plates are termed *axials*, and are spoken of as the *axillary costals*, *axillary distichals*, or whatever they may be.

The arms of the crinoids consist of brachial plates, and are in reality nothing more than the continuation of the branches of the rays after they have become free from the calyx. In some cases, as in figure 14, all the brachial plates are also arm plates. The arms may be either simple and undivided, as in figure 13, or on the other hand they may bifurcate to a greater or less degree, as in figures 14 and 15. In the more primitive

crinoids, such as those illustrated in figures 13 and 14, each arm or each branch of the arm consists of but a single series of plates, or is *uniserial*. A higher type of arm structure is found in the *biserial* arms, which are constituted of a double alternating series of plates, as in figure 15. Some of the uniserial arms are constituted of cuneate plates with their thinner edges arranged alternately, and these really constitute a type

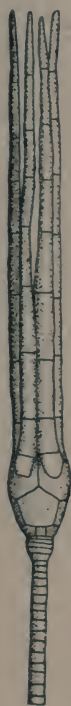


FIG. 13.



FIG. 14.

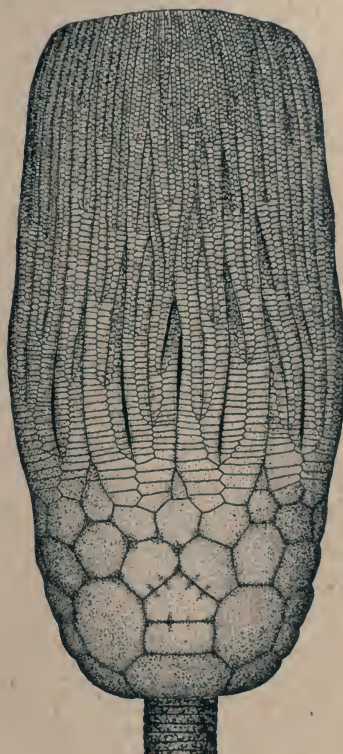


FIG. 15.

FIG. 13.—*Pisocrinus flagellifer* (after Angelin). A crinoid illustrating the simplest type of arms.

FIG. 14.—*Cyathocrinus ramosus* (after Angelin). A crinoid illustrating branching arms, all the brachial plates being free from the calyx.

FIG. 15.—*Corymbocrinus polydactylus* (after Angelin). A crinoid illustrating branching arms, the lower brachial plates being incorporated in the calyx.

intermediate between the uniserial arms with rectangular plates and the biserial type. Indeed, in many crinoids the arms are uniserial at the base with cuneate plates, the thin edge of the successive plates growing thinner and thinner until they

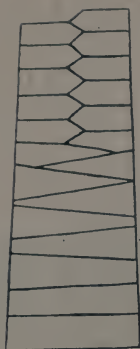


FIG. 16.—Diagram illustrating the change from uniserial to biserial type of structure in a single crinoid arm.

do not reach the outside, at which point the arm becomes a biserial one, constituted of two series of interlocking plates. Figure 16 shows diagrammatically this change from the uniserial to the biserial type in a single arm.

Usually each plate in the arms gives rise laterally to a *pinnule*, the position of which is shown diagrammatically in figure 17, the pinnule itself being indicated at *p*. In structure the pinnules are in every respect nothing more than miniature arms.

In the biserial arms each successive plate on either side bears a pinnule, but in the uniserial arms alternate plates give rise to pinnules on opposite sides, because no arm plate ever bears more than a single pinnule. In some crinoids each successive pair, or sometimes a greater number of arm plates, are joined transversely by a rigid suture and form a *syzygy*. In such cases only the distal or *epizygal* plate bears a pinnule, the proximal or *hypozygal* plate having no such appendage.

Both the arms and the pinnules are traversed longitudinally along their ventral sides by a deep groove or furrow, the *ambulacral* or *food groove*. This groove is shown diagrammatically in figures 17 and 18, each of which represents the cross section of a crinoid arm. In each diagram the depression *ag* is the ambulacral groove. These grooves are continued upon the ventral disk, where they converge and join into five main trunks, one from each ray, and these five meet at the mouth, which is situated at the center of the disk. In some crinoids, as is shown diagrammatically in figure 18, the ambulacral grooves are arched over by a series of small movable *covering plates*,

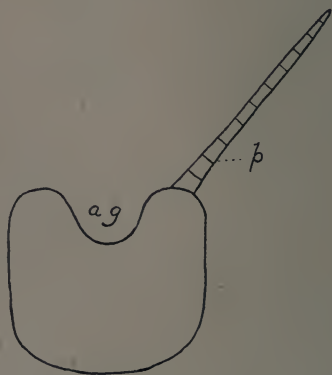


FIG. 17.—Diagrammatic cross section of a crinoid arm, showing position of pinnule *p*, and ambulacral groove *ag*.

marked *cp* in the diagram. In the living crinoids, and presumably in the fossil forms also, the ambulacral groove is lined by a ciliated epithelium, the moving cilia producing currents of water which pass along the groove and transport to the mouth the minute organisms which serve as food. There is also present in the living crinoids, and therefore presumably in the extinct forms, beneath the food groove proper in each arm, a tubular prolongation of the body cavity, besides genital, water, and vascular canals and a nerve cord. Besides this, many crinoids, both living and fossil, have the dorsal portion of each arm perforated longitudinally by an *axial canal*, *ax* in figure 18, containing elastic fibers and nervous matter. The axial canal, when present, extends also into the radials and basals, perforating the plates when they are thick and passing along a shallow groove upon their inner sides when they are thin.

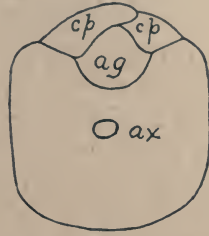


FIG. 18.—Diagrammatic cross section of a crinoid arm, showing ambulacral groove *ag*, covering plates *cp*, and axial canal *ax* (after Bather).



FIG. 19.

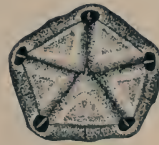


FIG. 20.

FIGS. 19 and 20.—Lateral and ventral views of *Haplocrinus mespiliformis* (after Wachsmuth and Springer). A very simple crinoid whose calyx consists only of basal, radial, and oral plates.

Upon the ventral disk, and surrounding or covering the mouth, are the five *orals* which constitute the third group of primary plates. These plates are among the earliest to develop in the larval crinoid (see Fig. 7), and are situated interradially, directly above the radials. In the more primitive crinoids, as shown in figures 19 and 20, the orals are triangular in form and rest directly upon the radials, entirely covering the ventral side. In a large number of crinoids the mouth and the ambulacral furrows upon the ventral disk are entirely covered by the orals alone, or by the orals and additional supplementary plates. In such cases the mouth and furrows are said

to be *subtegmina*, and the ambulacral furrows of the arms enter the calyx through *arm openings*, which are shown in figures 21 and 22. Sometimes the orals are situated in the angles between the ambulacral furrows upon the ventral disk, not covering the mouth or furrows. In such cases the covering plates of the ambulacral furrows upon the arms may continue across the disk to the mouth, and constitute what have been called the radial dome plates.



FIG. 21.

FIG. 21.—*Dorycrinus ræmeri* (after Meek and Worthen). A crinoid in which the anal opening passes directly through the vault.



FIG. 22.

FIG. 22.—*Batocrinus longirostris* (after Keyes). A crinoid in which the anal opening is situated at the end of an anal tube or proboscis.

The supplementary plates of the calyx are introduced between those already described, both in the dorsal cup and the ventral disk, for the purpose of increasing the capacity of the visceral cavity. They are of course present in the dorsal cup only in those crinoids which have some of the lower brachial plates included in the calyx. The larger number lie between the rays, and are therefore called *interradials*; but a distinction is made as a matter of convenience between the interradials of the dorsal and those of the ventral sides, the former being

called *interbranchials* and the latter *interambulacrals*. Besides the interradials, there are sometimes present supplementary plates between the divisions of the rays, and these are called *interdistichals* or *interpalmars*, whichever they may be.

The anal opening of the crinoid, situated interradially upon the ventral disk, is the chief disturbing element in the perfectly pentamerous radiate symmetry of the animal, and often accentuates the bilateral symmetry to a high degree. In the great majority of Paleozoic crinoids in which the mouth is subterminal, the anal opening is the only opening in the calyx aside from the arm openings, and for this reason it was mistaken by the earlier students of the crinoids for the mouth. The orientation of the calyx is determined entirely by the position of the anal opening, that interradius in which it is situated always being considered as the posterior one. The ray directly opposite is the anterior ray, the four others being the right and left anterior and the right and left posterior rays, these names being applied when the calyx is held with the ventral disk uppermost and the posterior side toward the observer. The terms *proximal* and *distal* are applied to any plate in the calyx or arms to indicate the direction toward or away from the point of attachment to the column.

The anal opening may be directly through the disk or it may be situated at the end of a *proboscis* or *anal tube* of greater or less length, constituted of calcareous plates similar to those in the disk. These two conditions are well shown in figures 21 and 22, in both of which the arms are entirely removed, leaving only the bare calyx. The function of the anal tube was probably hygienic, to remove the anal opening as far as possible from the neighborhood of the arms, so that the water passing into the calyx and bearing food to the mouth might not be contaminated.

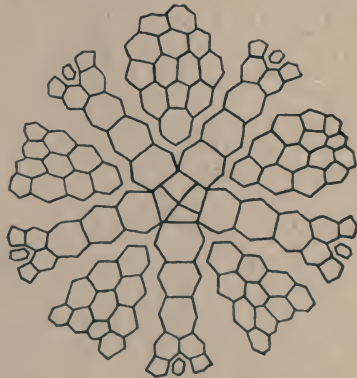


FIG. 23.—A diagram of the plates in the dorsal cup of *Melocrinus*, illustrating the greater number of plates in posterior or anal interradius.

The number of interradial plates upon the posterior or

anal side is usually greater, and their arrangement usually differs from the other sides, because of the disturbance in the symmetry caused by the presence of the anal opening. The additional plates in this interradius for the accommodation of the anal opening are sometimes confined wholly to the ventral disk, but are often crowded down into the dorsal cup. In the diagrammatic figure 23 the posterior interradius is placed uppermost, and a careful examination will show that it differs from the four other interradial areas in its larger number of plates, these additional plates being necessary for the accommodation of the anal opening upon the ventral side. In many crinoids in which none of the brachial plates are incorporated into the calyx there is present below, and to the right of the special anal plate, a plate which is in part radial in position. This is called the *radianal*, and is in reality the lower division of a compound radial plate.

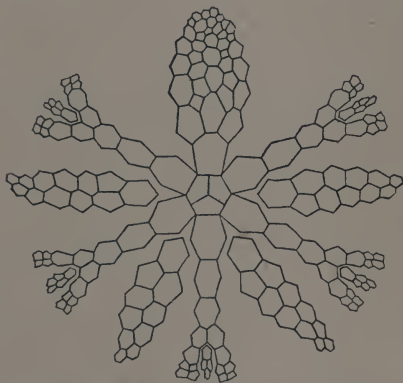


FIG. 24.—A diagram of the plates in the dorsal cup of *Periechocrinus*, illustrating the large anal plate in line with the radials.

In a considerable number of genera, as shown in the diagrammatic figure 24, a large anal plate has been crowded down between the two posterior radials, and is in contact with the basals, so that the circle of plates immediately following the basals contains six instead of five plates. In such instances, however, a careful examination will always show that only five of the plates are radials, the sixth one

being somewhat different in form from the others and not giving support to a series of plates which lead up to a ray.

In many of those crinoids whose ventral side is covered by a solid dome of plates the anal opening has crowded the posterior oral in between the other four, so that it is situated at almost the exact center of the disk. In others, particularly in those in which a prominent anal tube is present, all the orals are so crowded as to be entirely beyond recognition, the whole dome being constituted of rather small, irregularly arranged polygonal plates.

In many crinoids whose brachial plates are all free from the calyx, the capacity of the visceral cavity is increased in a very different manner from those whose lower brachials are incorporated in the calyx. The posterior interradius of the ventral disk becomes distended to a greater or less extent, forming a *ventral sac*. This is shown in figure 25, where the ventral sac may be seen reaching up between and above the arms. The ventral sac must not be confused, however, with the anal tube, because they are two totally different structures, although they have a similar position and may have a somewhat similar form. That the ventral sac is not primarily for the accommodation of the anal opening is shown by the fact that this opening is sometimes situated upon the disk in front of a highly developed ventral sac, sometimes in the side of the sac at a greater or less distance from its base, and seldom in the terminal portion of the sac. In some crinoids the ventral sac attains remarkable dimensions, extending upward for a distance as great or greater than the length of the arms.

Aside from the larger openings through the walls of the calyx already described, the anal opening and the arm openings, there are often present in various portions of the body much smaller openings or pores, usually obscured in the process of fossilization because of their small size. These minute openings are often present near the bases of the arms, and in those crinoids possessing a ventral sac they are often situated upon that portion of the body. Their function is not definitely understood, though it is supposed that they had to do with the respiration in the living animal. In some crinoids the stems are unusually large, with very large axial canals, and pores similar to those in the bodies of some other crinoids are present in the stems, and it is believed that these pores are also respiratory in function.



FIG. 25.—*Poteriocrinus circumtextus* (after Miller and Gurley). A crinoid with a well defined ventral sac.

THE CLASSIFICATION OF THE CRINOIDEA.*

The most important characters for dividing the Crinoidea into orders are: (1) the condition of the arms, whether free above the radials or partly incorporated into the calyx; (2) the mode of union between the plates of the calyx, whether movable or immovable; and (3) the condition of the stem, whether the young joints were formed beneath the proximal ring of the calyx or beneath the top stem joint. The morphological importance of these characters is shown by the fact that among the oldest crinoids they appear as well differentiated as among those of later epochs, which indicates that their origin dates back to a much earlier time. The division of the crinoids into three orders, *Inadunata*, *Camerata*, and *Articulata*, is based entirely upon these three sets of characters.

The order *Inadunata* represents the simplest form. In it the dorsal cup is composed invariably of two rings of plates, or three when infrabasals are present. No supplementary plates are present except an anal plate, and this is not present in all. The radials are always in lateral contact on four sides, and when no anal plate exists, on the fifth side also. The arms are free from the radials up.

In the structure of the ventral disk of the *Inadunata* two different plans are recognized, the one exhibiting the utmost simplicity, being composed exclusively of five large oral plates forming a pyramid; the other showing considerable complexity at the posterior interradius, which is drawn out into a sac or tube. Based upon these two plans of structure the *Inadunata* are divided into two suborders, the *Larviformia* and the *Fistulata*.

The name *Larviformia* is suggested by the very primitive characters of the members of the suborder. One can scarcely imagine a more complete parallelism than exists between these ancient larviform crinoids and the larval stage of recent ones.

*This chapter is essentially a condensation of pages 144 to 170 of "The North American Crinoidea *Camerata*," by Wachsmuth and Springer. Much of the language used here is essentially that of these authors. The analytical keys to orders and genera are also from the same authors.

The calyx of the Larviformia consists of but few plates, the basals, occasionally infrabasals, radials and orals, the latter forming a closed pyramid which rests against the radials. The



FIG. 26.

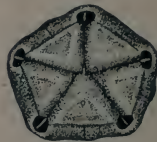


FIG. 27.

FIGS. 26 and 27.--Two views of *Haplocrinus mespiliformis* (after Wachsmuth and Springer). Illustrating the simplicity of the calyx in Larviformia.

mouth is closed and the ambulacra are not exposed to view. The calyx of these simple crinoids is well shown in figures 26 and 27. The anus is eccentric, either piercing the posterior oral or situated between the posterior oral and the radials.

The arms are simple, as shown in figure 28, non-pinnulate, one to each ray, and are composed of long quadrangular joints which, except upon the radials, are united by close suture. The total absence of supplementary plates, the compound nature of the radials in the earlier forms, are other primitive features characteristic of this group.

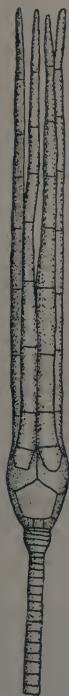


FIG. 28.—*Pisocrinus flagellifer* (after Angelin). A larviform crinoid illustrating the simplicity of the arms in this suborder.

The suborder *Fistulata* includes those inadunate crinoids which have developed a ventral sac, the name having reference to this swelling upon the ventral disk. This feature of the suborder is well illustrated in figure 29. The structure of the dorsal cup of the *Fistulata* agrees in a general way with that of the Larviformia. It consists of but two rings of plates, the basals and radials, or of three rings when infrabasals are present. The ventral disk, however, which is simple in the extreme in the Larviformia, is highly specialized in the *Fistulata* by reason of the extra-

giant development of the posterior interradius forming the sac. The sac rests upon the radials or is supported by the anal plate, and frequently, but not always, contains the anal opening. Owing to the large size of this sac, and the disturbance thereby produced in the symmetry of the animal, the whole calyx acquires a marked irregularity, which is still further increased in species with compound radials, so that the pentamerous symmetry and the bilateral also, is often supplanted by asymmetry. The anal opening is situated near the top of the sac, or at some point along its anterior side, and sometimes in front of the sac close to the mouth. The sac, at least sometimes, is



FIG. 29.—*Poteriocrinus circumtextus* (after Miller and Gurley). A fistulate crinoid illustrating the ventral sac, which is characteristic of this suborder.



FIG. 30.—*Cyathocrinus ramosus* (after Angelin). Illustrating the arm structure of the fistulate crinoids.

pierced by pores which are believed to have respiratory functions. In some groups, in which the sac is not perforated, there is situated upon the ventral disk, directly behind the mouth, a poriferous plate which probably performed the same function as the pores in the sacs of others. The arms of the *Fistulata* are branching to a greater or less degree, figure 30 being a good example; they are usually uniserial, only near the close of the life history of the suborder, at the end of paleozoic time, is the biserial arm structure introduced.

The order *Camerata* is characterized by the large number of supplementary plates introduced in the calyx. These are distributed almost equally throughout the five sides of the calyx, and by means of them the proximal brachial plates are in-

corporated into the calyx for some distance, thereby increasing the capacity of the visceral cavity. All the plates of the calyx are heavy and immovable, being united by close sutures, hence the name camerata, or box crinoids. The symmetry of the dorsal cup is either strictly pentamerous or sub-bilateral, the asymmetry which is so characteristic of some of the *Fistulata* never being found in the *Camerata*. The base is monocyclic or dicyclic, and the mouth and food grooves are perfectly closed. The arms, or at least the rays, are always branching, and, except in some of the earlier genera, the arms are biserial in structure.

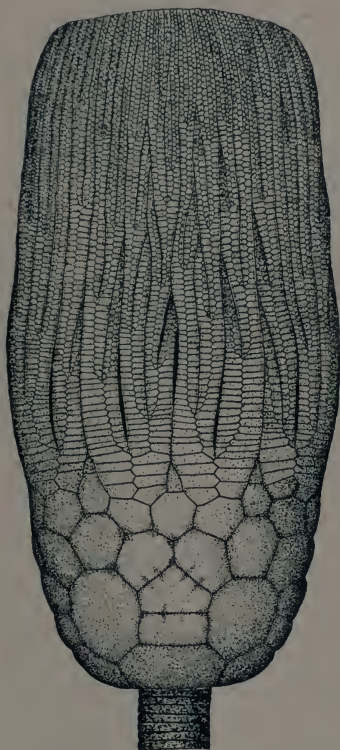


FIG. 31.—*Corymbocrinus polydactylus* (after Angelin). A typical representative of the camerate crinoids.

The *Camerata* are a highly specialized type and constitute a compact and well-limited natural group. They represent a type of rapid culmination and development, possessing, even in the earliest known forms, well-defined pinnules, and the biserial arm structure in most of the families was permanently established by the close of Silurian time. The members of the order fall naturally into two sections: (1) Those in which the lower brachials and interradians form an important part of the dorsal cup, and (2) those in which the brachials retain the form and small size of arm plates, and in which the interradians are almost exclusively

confined to the ventral side. The first of these are the typical *Camerata*, of which figure 31 is a characteristic example. The second, or non-typical section, represents a stage in which the modification of the *Inadunate* type by camerate tendencies had progressed only to a limited extent.

The members of the third order, *Articulata*, agree with the *Camerata* in having their lower brachials incorporated into the

calyx helping to inclose the visceral mass, but the plates from the radials up, instead of being united by close sutures, are movable one upon the other. The incorporation of the brachials into the dorsal cup took place by lateral union among themselves, by the introduction of supplementary plates, or by means of an incrustated or naked skin. The mouth and food grooves are exposed upon the ventral disk. The base is dicyclic, but the infrabasals are fused with the top stem joint, which, throughout this order, is not the youngest joint of the stem. Figure 32 is a good illustration of one of the paleozoic members of the order.



FIG. 32.—*Ichthyocrinus intermedius* (after Angelin). Illustrating the articulate crinoids.

The Articulata are divided into two suborders, (1) the *Impinnata*, or those which are destitute of pinnules, and (2) the *Pinnata*, or those in which pinnules are present.

For the division of the orders or suborders into groups of less taxonomic rank various characters are found to be of use. The supplementary plates afford excellent criteria for separating the crinoids into primary divisions, but they are also of great importance in the separation of families. Among the supplementary plates the anals unquestionably take the first rank. The absence of anals, their introduction into the calyx, and the relations they bear to adjoining plates—whether introduced between the radials or brachials, or between both of them—are very important, but the same characters have not the same taxonomic value in every group. The differentiations produced by the anal plates are considered of family importance among the Camerata, but among the Fistulata and Impinnata they appear to be of generic value only. The nature of the base, whether monocyclic or dicyclic, is usually a valuable character for family distinctions. The presence or absence of pinnules is an important family character. The number of basals and infrabasals is of generic value only. The condition of the arms, their simplicity, their mode of branching and the arrangement of their plates—whether uniserial or biserial—afford useful characters for distinguishing genera. The condition of the anal opening, whether a simple opening

through the ventral disk or situated at the end of a tube, is usually regarded as of generic value.

The specific characters are more superficial. They consist largely in the varying proportions and sizes of plates, sometimes in differences in the number and arrangement of supplementary plates, and very often in the surface ornamentation of the plates which may be of specific importance.

ANALYTICAL KEY TO THE ORDERS AND FAMILIES OF CRINOIDEA.*

Class CRINOIDEA.

Echinoderms which are attached, during a part or all of their life, to external objects, either by means of a stem or directly by the abactinal side of the calyx. The visceral mass inclosed by a calcareous test or calyx, constructed of plates more or less symmetrically arranged, and giving off well-defined free arms from the sides. Mouth directed upwards.

- I. Crinoids in which the arms are free above the radials.
The top joint the youngest in the stem.....Order, *Inadunata*
 - A. Disk composed of orals only. Ambulacra subteg-
minal.....Suborder, *Larviformia*
 - B. Posterior side of the disk extended into a sac. Am-
bulacra supra-tegmina.....Suborder, *Fistulata*
- II. Crinoids in which the lower brachials take part in the dorsal cup. All plates of the calyx united by close suture. Mouth and food grooves closed. Top joint the youngest in the stem.....Order, *Camerata*
- III. Crinoids in which the lower brachials are incorporated into the calyx either by lateral union with each other, or by supplementary plates, or a calcareous skin. All plates from the radials up movable. Mouth and food grooves exposed. The top stem joint fused with the infrabasals, and not the youngest joint of the stem.....Order, *Articulata*
 - A. Arms non-pinnateSuborder, *Impinnata*
 - B. Arms pinnulate.....Suborder, *Pinnata*

I. INADUNATA.

1. Monocyclic.
*Body small and rarely preserved, the stem coiled around it.
.....Genus, *Myelodactylus*
2. Dicyclic.
 1. Calyx globose or turbinate. Radials with horseshoe-shaped facets supporting two or more brachials. Arms without true pinnules.....Family, *Cyathocrinidae*

*In the table for families only such families as are present in the Chicago fauna are included.

II. CAMARATA.

- A. **Typical Section.** Lower brachials and interbrachials forming an important part of the dorsal cup.
1. Dicyclic.
 - a. Radials in contact except at the posterior side.
..... Family, *Thysanocrinidæ*
 - b. Radials separated all around..... Family, *Rhodocrinidæ*
 2. Monocyclic.
 - a. Radials in contact all around.
*Symmetry of the dorsal cup, if not strictly pentam-
erous, disturbed by the introduction of anals be-
tween the brachials only..... Family, *Melocrinidæ*
*Arms borne in compartments formed by partitions
attached to the tegmen. Dorsal cup perfectly
pentamerous. Plates of the calyx limited to a
definite number..... Family, *Calyptocrinidæ*
 - b. Radials in contact except at the posterior side,
where they are separated by an anal plate.
*First anal plate heptagonal, followed by three plates,
a second anal and two interbrachials..... Family, *Batocrinidæ*
- B. **Non-typical Section.** Brachials and interbrachials but slightly represented in the dorsal cup.
1. Monocyclic.
 - a. Radials in contact all around. Base pentagonal.
..... Family, *Platycrinidæ*
 2. Dicyclic.
 - a. Radials in contact except at the posterior side.
..... Family, *Crotalocrinidæ*

III. ARTICULATA.

1.  Underbasals unequal. The plates of the base often very small. Arms uniserial, bifurcating, generally in contact laterally so as to form a wall continuous with the calyx.
..... Family, *Ichthyocrinidæ*

GENERA OF UNCERTAIN AFFINITY.

1.  Dorsal cup constituted of three basals and five radials which are deeply notched at their distal ends... Genus, *Stephanocrinus*
2. Dorsal cup constituted of three basals and four elongate radials..... Genus, *Zophocrinus*

GENERA OF SILURIAN CRINOIDEA, WITH GEOGRAPHIC DISTRIBUTION

GENERA	North. Ill. & Wis.	Iowa	Indiana	Kentucky	Tennessee	Ohio	New York	Gotland	England	Bohemia	Australia
<i>Abacocrinus</i> , Ang.	..	..	..	..	..	..	..	*	..	..	..
<i>Acacocrinus</i> , W. & S.	..	..	..	*	..	..	..	..	..	..	..
<i>Allocrinus</i> , W. & S.	..	..	..	*	..	..	..	..	..	..	..
<i>Ampheristocrinus</i> , H.	*	..	*	..	..	..	..	..	..	..	..
<i>Anisocrinus</i> , Ang.	..	..	..	..	..	..	..	*	..	..	..
<i>Anthemocrinus</i> , W. & S.	..	..	..	..	..	..	..	*	..	..	..
<i>Arachnocrinus</i> , M. & W.	..	..	..	..	*	..	..	..	..	..	..
<i>Archæocrinus</i> , W. & S.	*	..	..	..	..	..	..	..	..	..	..
<i>Barrandeocrinus</i> , Ang.	..	..	..	..	..	..	..	*	..	..	..
<i>Botryocrinus</i> , Ang.	*	..	*	..	..	..	..	*	*	..	..
<i>Briarocrinus</i> , Ang.	..	..	..	..	..	..	..	*	..	..	..
<i>Calceocrinus</i> , Hall.	..	..	*	..	..	..	*	..	*	..	..
<i>Callicrinus</i> , D'Orb.	*	..	*	..	*	..	..	*	..	..	..
<i>Calpiocrinus</i> , Ang.	..	..	..	..	..	..	..	*	..	..	..
<i>Chicagocrinus</i> , Weller.	*	..	..	..	..	..	..	..	..	..	..
<i>Cococrinus</i> , Müll.	..	..	..	..	*	..	..	..	..	..	..
<i>Cordylocrinus</i> , Ang.	..	..	..	..	..	..	..	*	..	..	..
<i>Corymbocrinus</i> , Ang.	..	..	..	..	..	..	..	*	..	..	..
<i>Crotalocrinus</i> , Austin.	*	..	..	..	..	..	..	*	*	..	..
<i>Cyathocrinus</i> , Miller.	..	..	*	..	..	..	..	*	*	..	..
<i>Cylicocrinus</i> , S. A. M.	..	..	*	..	..	..	..	..	..	..	..
<i>Cyphocrinus</i> , S. A. M.	*	..	*	..	..	..	..	..	..	..	..
<i>Cyrtidocrinus</i> , Ang.	..	..	..	..	..	..	*	*	..	..	..
<i>Dendrocrinus</i> , Hall.	..	..	..	..	..	..	*	..	..	..	..
<i>Desmidocrinus</i> , Ang.	..	..	..	..	..	..	..	*	..	..	..
<i>Emperocrinus</i> , M. & G.	..	..	*	..	..	..	..	..	..	..	..
<i>Enallocrinus</i> , D'Orb.	..	..	..	..	..	..	..	*	*	..	..
<i>Eucalyptocrinus</i> , Goldf.	*	..	*	..	*	*	*	*	*	..	..
<i>Euchirocrinus</i> , M. & W.	..	..	*	..	..	..	*	..	..	..	..
<i>Euspiocrinus</i> , Ang.	..	..	..	..	..	..	..	*	..	..	..
<i>Gazacrinus</i> , S. A. M.	*	..	*	..	*	..	*	..	..	..	..
<i>Gissocrinus</i> , Ang.	..	..	..	..	..	..	..	*	*	..	..
<i>Gnorimocrinus</i> , W. & S.	..	..	..	..	..	..	..	*	..	..	..
<i>Gothocrinus</i> , Bather.	..	..	..	..	..	..	..	*	..	..	..
<i>Habrocrinus</i> , Ang.	..	..	..	..	..	..	..	*	*	..	..
<i>Haplocrinus</i> , Stein.	..	..	..	..	..	..	..	..	..	..	*
<i>Homalocrinus</i> , Ang.	..	..	..	..	..	..	..	*	..	..	..
<i>Homocrinus</i> , Hall.	..	..	*	..	..	..	*	*	..	..	..
<i>Ichthyocrinus</i> , Con.	*	..	*	..	..	..	*	*	*	..	..
<i>Indianocrinus</i> , M. & G.	..	..	*	..	..	..	..	..	..	..	..
<i>Lampteroocrinus</i> , Roem.	*	..	*	..	*	..	..	..	..	..	..
<i>Lecanocrinus</i> , Hall.	*	..	*	*	*	..	*	*	..	..	..

GENERA	North. Ill. & Wis.									
	Iowa	Indiana	Kentucky	Tennessee	Ohio	New York	Gotland	England	Bohemia	Australia
<i>Leptocrinus</i> , Ang.....	*						*			
<i>Lithocrinus</i> , W. & S.....	*						*			
<i>Lyriocrinus</i> , Hall.....	*	*								
<i>Macrostylocrinus</i> , Hall.....	*	*	*			*	*			
<i>Mariacrinus</i> , Hall.....	*						*			
<i>Marsupiocrinus</i> , Phill.....	*			*	*		*	*		
<i>Mastigocrinus</i> , Bather.....	*			*	*		*	*		
<i>Melocrinus</i> , Goldf.....	*	*	*	*		*	*	*		
<i>Myelodactylus</i> , Hall.....	*			*	*	*	*	*		
<i>Patellocrinus</i> , Ang.....	*			*	*		*	*		
<i>Periechocrinus</i> , Austin.....	*	*		*	*		*	*		
<i>Petalocrinus</i> , Weller.....	*	*		*		*	*	*		
<i>Pisocrinus</i> , DeKon.....	*	*		*		*	*	*		
<i>Platycrinus</i> , Miller.....	*	*				*	*	*		
<i>Polypeltes</i> , Ang.....	*						*	*		
<i>Pycnosaccus</i> , Ang.....	*						*	*		
<i>Sagenocrinus</i> , Ang.....	*						*	*		
<i>Scyphocrinus</i> , Zenker.....	*						*	*	*	
<i>Siphonocrinus</i> , S. A. M.....	*						*	*		
<i>Stelidiocrinus</i> , Ang.....	*	*				*	*	*		
<i>Stephanocrinus</i> , Con.....	*	*				*	*	*		
<i>Streptocrinus</i> , W. & S.....	*					*	*	*		
<i>Taxocrinus</i> , Phill.....	*					*	*	*		
<i>Thalamocrinus</i> , M. & G.....	*			*		*	*	*		
<i>Thenarocrinus</i> , Bather.....	*	*	*	*		*	*	*		
<i>Thysanocrinus</i> , Hall.....	*	*	*	*		*	*	*		
<i>Zophocrinus</i> , S. A. M.....	*	*				*	*	*		

LIST OF SPECIES OF SILURIAN CRINOIDEA WITH GEOGRAPHIC DISTRIBUTION

SPECIES	North. Ill. and Wis.	Iowa	Indiana	Kentucky	Tennessee	Ohio	New York	Gotland	England	Bohemia	Australia
Abacocrinus , Ang.											
<i>cappelleri</i> , Ang.....								*			
<i>medius</i> , Ang.....								*			
<i>tessellatus</i> , Ang.....								*			
<i>tesseracontadactylus</i> , Ang.....								*			
Acacocrinus , W. & S.											
<i>americanus</i> , W. & S.....			*								
<i>elrodi</i> , W. & S.....			*								
Allocrinus , W. & S.											
<i>benedicti</i> , W. & S.....			*								
<i>typus</i> , W. & S.....					*						
Ampheristocrinus , Hall.											
<i>dubius</i> , Weller.....	*										
<i>typus</i> , H.....			*								
Anisocrinus , Ang.											
<i>angelini</i> , W. & S.....								*			
<i>interradiatus</i> , Ang.....								*			
Anthemocrinus , W. & S.											
<i>minor</i> , Ang.....								*			
<i>venustus</i> , Ang.....								*			
Arachnocrinus , M. & W.											
<i>pisiformis</i> , Roem.....					*						
Archæocrinus , W. & S.											
<i>depressus</i> , Weller.....	*										
Barrandeocrinus , Ang.											
<i>sceptrum</i> , Ang.....								*			
Botryocrinus , Ang.											
<i>œmulus</i> , Hall.....			*								
<i>cucurbitaceus</i> , Ang.....								*			
<i>nucleus</i> , Hall.....			*								
<i>pinnulatus</i> , Bather.....									*		
<i>polyxo</i> , Hall.....	*		*								
<i>quinguelobus</i> , Bather.....									*		
<i>ramosissimus</i> , Ang.....								*			
Briarocrinus , Ang.											
? <i>angustus</i> , Ang.....								*			
<i>inflatus</i> , Ang.....								*			
Calceocrinus , Hall.											
<i>bidentatus</i> , Ring.....							*				
<i>contractus</i> , Ring.....							*				
<i>fletcheri</i> , Salter.....									*		
<i>gothlandicus</i> , Ang.....								*			
<i>halli</i> , Ring.....							*				
<i>interpres</i> , Bather.....								*			
<i>nitidus</i> , Bather.....								*			
<i>pinnulatus</i> , Bather.....								*			
<i>pugil</i> , Bather.....								*			
<i>stigmatus</i> , Hall.....			*					*			
<i>tenax</i> , Bather.....								*			
<i>tucanus</i> , Bather.....								*			
<i>typus</i> , Ring.....							*				

SPECIES	North. Ill. and Wis.	Iowa	Indiana	Kentucky	Tennessee	Ohio	New York	Gotland	England	Bohemia	Australia
Callicrinus , D'Orb.											
<i>acanthinus</i> , Ring.....	..	..	..	..	..	..	*	..	..	..	..
<i>beechleri</i> , W. & S.....	..	..	*	..	..	..	..	*	..	..	..
<i>beyrichianus</i> , Ang.....	..	..	..	..	..	..	..	..	..	..	..
<i>bifurcatus</i> , Weller.....	*	..	..	..	..	..	..	..	..	..	..
<i>bilobus</i> , Weller.....	*	..	..	..	..	..	..	..	..	..	..
<i>cornutus</i> , Hall.....	*	..	..	..	..	..	..	..	..	..	..
<i>corrugatus</i> , Weller.....	*	..	..	..	..	..	..	..	..	..	..
<i>costatus</i> , His.....	..	..	..	..	..	..	..	*	..	..	..
<i>desideratus</i> , Weller.....	*	..	..	..	..	..	..	..	..	..	..
<i>diadema</i> , Ang.....	..	..	..	..	..	..	..	*	..	..	..
<i>digitatus</i> , Weller.....	*	..	..	..	..	..	..	..	..	..	..
<i>hydei</i> , Weller.....	*	..	..	..	..	..	..	..	..	..	..
<i>koninckianus</i> , Ang....	..	..	..	..	..	..	..	*	..	..	..
<i>longispinus</i> , Weller.....	*	..	..	..	..	..	..	..	..	..	..
<i>minor</i> , Ang.....	..	..	..	..	..	..	..	*	..	..	..
<i>murchisonianus</i> , Ang.....	..	..	..	..	..	..	..	*	..	..	..
<i>pentangularis</i> , Weller ..	*	..	..	..	..	..	..	..	..	..	..
<i>ramifer</i> , Roem.....	..	..	..	..	*	..	..	..	..	..	..
<i>roemerianus</i> , Ang.....	..	..	..	..	..	..	..	*	..	..	..
<i>sedgwickianus</i> , Ang.....	..	..	..	..	..	..	..	*	..	..	..
Calpiocrinus , Ang.											
<i>fimbriatus</i> , Ang.....	..	..	..	..	..	..	..	*	..	..	..
<i>heterodactylus</i> , Ang.....	..	..	..	..	..	..	..	*	..	..	..
<i>humilis</i> , Ang.....	..	..	..	..	..	..	..	*	..	..	..
<i>ovatus</i> , Ang.....	..	..	..	..	..	..	..	*	..	..	..
<i>pyrum</i> , Ang.....	..	..	..	..	..	..	..	*	..	..	..
Chicagocrinus , Weller.											
<i>inornatus</i> , Weller.....	*	..	..	..	..	..	..	..	..	..	..
<i>ornatus</i> , Weller.....	*	..	..	..	..	..	..	..	..	..	..
Coccocrinus , Müll.											
<i>bacca</i> , Roem.....	..	..	..	..	*	..	..	..	..	..	..
Cordylocrinus , Ang.											
<i>comtus</i> , Ang.....	..	..	..	..	..	..	..	*	..	..	..
Corymbocrinus , Ang.											
<i>chicagoensis</i> , Weller.....	*	..	..	..	..	..	..	..	..	..	..
<i>corolliferus</i> , His.....	..	..	..	..	..	..	..	*	..	..	..
<i>grandis</i> , Ang.....	..	..	..	..	..	..	..	*	..	..	..
<i>grandistellatus</i> , Ang... ..	..	..	..	..	..	..	..	*	..	..	..
<i>lævis</i> , Ang.....	..	..	..	..	..	..	..	*	..	..	..
<i>niagarensis</i> , Weller.....	*	..	..	..	..	..	..	..	..	..	..
<i>panderi</i> , Ang.....	..	..	..	..	..	..	..	*	..	..	..
<i>polydactylus</i> , McCoy.....	..	..	..	..	..	..	..	*	*	..	..
Crotalocrinus , Austin.											
<i>americanus</i> , Weller	*	..	..	..	..	..	..	..	..	..	..
<i>pulcher</i> , His.....	..	..	..	..	..	..	..	*	..	..	..
<i>rugosus</i> , Miller.....	..	..	..	..	..	..	..	*	*	..	..
<i>superbus</i> , Ang.....	..	..	..	..	..	..	..	*	..	..	..
Cyathocrinus , Miller.											
<i>acinotubus</i> , Ang.....	..	..	..	..	..	..	..	*	*	..	..
<i>benedicti</i> , S. A. M.....	..	..	*	..	..	..	..	..	..	..	..
<i>capillaris</i> , Phill.....	..	..	..	..	..	..	..	..	*	..	..
<i>cora</i> , Hall.....	*	..	..	..	..	..	..	..	..	..	..
<i>diana</i> , Bather.....	..	..	..	..	..	..	..	*	..	..	..
<i>distensus</i> , Ang.....	..	..	..	..	..	..	..	*	..	..	..
<i>dudleyensis</i> , Aust.....	..	..	..	..	..	..	..	..	*	..	..
<i>glaber</i> , Ang.....	..	..	..	..	..	..	..	*	..	..	..
<i>longimanus</i> , Ang.....	..	..	..	..	..	..	..	*	..	..	..

[illegible]

SPECIES	North Ill. and Wis.	Iowa	Indiana	Kentucky	Tennessee	Ohio	New York	Gotland	England	Bohemia	Australia
Eucalyptocrinus, Goldf. Cont.											
<i>speciosus</i> , Ang.....						*		*			
<i>splendidus</i> , Troost.....						*					
<i>tuberculatus</i> , M. & D.....	*		*				*				
<i>turbinatus</i> , S. A. M.....	*										
<i>ventricosus</i> , W. & S.....					*						
Euchirocrinus, M. & W.											
<i>chrysalis</i> , Hall.....							*				
<i>indianensis</i> , S. A. M.....			*								
<i>radiculus</i> , Ring.....							*				
Euspirocrinus, Ang.											
<i>spiralis</i> , Ang.....								*			
Gazacrinus, S. A. M.											
? <i>immaturus</i> , W. & S.....							*				
<i>inornatus</i> , S. A. M.....			*								
<i>major</i> , Weller.....	*										
<i>minor</i> , Weller.....	*										
? <i>tennesseensis</i> , W. & S.....					*						
<i>ventricosus</i> , W. & S.....			*								
<i>waldronensis</i> , M. & D.....			*								
Gissocrinus, Ang.											
<i>arthriticus</i> , Phill.....									*		
<i>campanulata</i> , Bather.....								*			
<i>elegans</i> , Ang.....								*			
<i>goniodactylus</i> , Phill.....								*	*		
<i>incurvatus</i> , Ang.....								*			
<i>macroductylus</i> , Ang.....								*			
<i>squamifer</i> , Salter.....								*	*		
<i>typus</i> , Bather.....								*			
<i>umbilicatus</i> , Ang.....								*			
<i>verrucosus</i> , Bather.....								*			
Gnorimocrinus, W. & S.											
<i>austini</i> , Ang.....								*			
<i>distensus</i> , Ang.....								*			
<i>expansus</i> , Ang.....								*			
<i>interbrachiatus</i> , Ang.....								*			
<i>loveni</i> , W. & S.....								*			
<i>oblongatus</i> , Ang.....								*			
<i>ovalis</i> , Ang.....								*			
<i>punctatus</i> , Ang.....								*			
<i>ringens</i> , Ang.....								*			
<i>salteri</i> , Ang.....								*			
<i>tubuliferus</i> , Ang.....								*			
Gothocrinus, Bather.											
<i>gracilis</i> , Bather.....								*			
Habrocrinus, Ang.											
<i>affinis</i> , Ang.....								*			
<i>annulatus</i> , Ang.....								*			
<i>cariosolus</i> , Ang.....								*			
<i>comptus</i> , Ang.....								*			
<i>decadactylus</i> , Ang.....								*			
<i>elegantulus</i> , Ang.....								*			
<i>fartus</i> , Ang.....								*			
<i>grandis</i> , Ang.....								*			
<i>granulatus</i> , Ang.....								*			
<i>laevis</i> , Ang.....								*			
<i>longimanus</i> , Ang.....								*			
<i>ornatissimus</i> , Ang.....								*			

SPECIES	North. Ill. and Wis.	Iowa	Indiana	Kentucky	Tennessee	Ohio	New York	Gotland	England	Bohemia	Australia
Habrocrinus, Ang.—Cont.											
<i>ornatus</i> , Ang.....								*			
<i>pinnulatus</i> , Ang.....								*			
<i>pulchellus</i> , Ang.....								*			
<i>robustus</i> , Ang.....								*			
<i>simplex</i> , Phill.....								*	*		
<i>tenuis</i> , Ang.....								*			
<i>umbonata</i> , Ang.....								*			
Hapalocrinus, Stein.											
<i>victoriae</i> , Bather.....											*
Homalocrinus, Ang.											
<i>parabasilis</i> , Ang.....								*			
Homocrinus, Hall.											
<i>ancilla</i> , Hall.....			*								
<i>cylindricus</i> , Hall.....							*				
<i>parvus</i> , Hall.....							*				
<i>tenuis</i> , Bather.....								*			
Ichthyocrinus, Conrad.											
<i>clintonensis</i> , H.....							*				
<i>conoideus</i> , Ring.....							*				
<i>gothlandicus</i> , W. & S.....								*			
<i>intermedius</i> , Ang.....								*			
<i>lævis</i> , Con.....							*				
<i>pyriformis</i> , Ang.....								*	*		
<i>simplex</i> , H.....							*				
<i>subangularis</i> , H.....	*		*								
Indianocrinus, M. & G.											
<i>punctatus</i> , M. & G.....			*								
Lampterocrinus, Roem.											
? <i>dubius</i> , Weller.....	*										
<i>inflatus</i> , Hall.....	*										
<i>parvus</i> , Hall.....			*								
<i>robustus</i> , Weller.....	*										
<i>subglobosus</i> , Weller.....	*										
<i>tennesseensis</i> , Roem.....					*						
Lecanocrinus, Hall.											
<i>billingsi</i> , Ang.....							*	*			
<i>calyculus</i> , Hall.....							*				
<i>excavatus</i> , Ring.....							*				
<i>greenei</i> , M. & G.....				*							
<i>incisus</i> , Ring.....							*				
<i>macropetalus</i> , Hall.....							*				
<i>nitidus</i> , Ring.....							*				
<i>ornatus</i> , Hall.....							*				
? <i>oswegoensis</i> , M. & G.....	*										
<i>pustillus</i> , Hall.....			*				*				
<i>puteolus</i> , Ring.....							*				
<i>solidus</i> , Ring.....							*				
<i>tennesseensis</i> , S. A. M.....					*						
<i>waukoma</i> , Hall.....	*										
Leptocrinus, Ang.											
<i>raridigitatus</i> , Ang.....								*			
Lithocrinus, W. & S.											
<i>divaricatus</i> , Ang.....								*			
<i>milleri</i> , Ang.....								*			
<i>obesus</i> , Ang.....								*			
<i>robustus</i> , Ang.....								*			

SPECIES	North. Ill. and Wis.	Iowa	Indiana	Kentucky	Tennessee	Ohio	New York	Gotland	England	Bohemia	Australia
Lyriocrinus , Hall.											
<i>dactylus</i> , Hall.....	*		*				*				
<i>melissa</i> , Hall.....											
Macrostylocrinus , Hall.											
<i>fasciatus</i> , Hall.....			*								
<i>fusibrachiatus</i> , Ring.....							*				
<i>granulosus</i> , Hall.....			*								
<i>indianensis</i> , M. & G.....			*								
<i>meeki</i> , Lyon.....				*							
<i>obconicus</i> , Weller.....	*										
<i>ornatus</i> , Hall.....							*				
<i>semiradiatus</i> , H.....	*										
<i>striatus</i> , Hall.....	*		*								
<i>subglobosus</i> , Weller.....	*										
Mariacrinus , Hall.											
<i>angustatus</i> , Ang.....								*			
<i>aureatus</i> , S. A. M.....			*								
<i>carleyi</i> , Hall.....			*								
<i>? granulosus</i> , S. A. M.....			*								
<i>warreni</i> , Ring.....							*				
Marsupiocrinus , Phill.											
<i>chicagoensis</i> , Weller.....	*										
<i>coelatus</i> , Phill.....									*		
<i>depressus</i> , Ang.....								*			
<i>præmaturus</i> , H. & W.....						*					
<i>pulcher</i> , Ang.....								*			
<i>radiatus</i> , Ang.....								*			
<i>rugulosus</i> , Ang.....								*			
<i>striatus</i> , W. & S.....					*						
<i>tennesseensis</i> , Roem.....					*						
Mastigocrinus , Bather.											
<i>loreus</i> , Bather.....									*		
Melocrinus , Goldf.											
<i>aqualis</i> , S. A. M.....			*								
<i>? granulatus</i> , Ang.....								*			
<i>obconicus</i> , Hall.....			*								
<i>oblongus</i> , W. & S.....			*	*							
<i>obpyramidalis</i> , W. & M.....	*										
<i>parvus</i> , W. & S.....			*								
<i>? rigidus</i> , Ang.....							*				
<i>roemeri</i> , W. & S.....					*						
<i>spectabilis</i> , Ang.....							*				
<i>volborthi</i> , Ang.....							*				
Myelodactylus , Hall.											
<i>ammonis</i> , Bather.....							*	*			
<i>brachiatus</i> , Hall.....							*				
<i>bridgeportensis</i> , S. A. M.....	*										
<i>convolutus</i> , Hall.....							*	*			
<i>flabellacirrus</i> , Bather.....							*				
<i>fletcheri</i> , Salt.....							*	*			
<i>gorbyi</i> , S. A. M.....					*		*				
Patelliocrinus , Ang.											
<i>duplicatus</i> , Ang.....							*				
<i>fulminatus</i> , Ang.....							*				
<i>interradiatus</i> , Ang.....							*				
<i>leptodactylus</i> , Ang.....							*				
<i>pachydactylus</i> , Ang.....							*				

SPECIES	North. Ill. and Wis.	Iowa	Indiana	Kentucky	Tennessee	Ohio	New York	Gotland	England	Bohemia	Australia
Patelloocrinus, Ang.—Cont.											
<i>plumulosus</i> , Ang.....								*			
<i>punctuosus</i> , Ang.....								*			
Periechocrinus, Austin.											
<i>articulosus</i> , Austin.....									*		
<i>benedicti</i> , S. A. M.....			*					*			
<i>brevimanus</i> , Ang.....								*			
<i>chicagoensis</i> , Weller.....	*										
<i>christyi</i> , Hall.....	*		*								
<i>egani</i> , S. A. M.....	*										
<i>gorbyi</i> , S. A. M.....			*								
<i>gothlandicus</i> , Pander.....								*			
<i>howardi</i> , S. A. M.....			*								
<i>infelix</i> , W. & M.....	*								*		
<i>interradiatus</i> , Ang.....									*		
<i>laevis</i> , Portlock.....									*		
<i>lindströmi</i> , W. & S.....								*			
<i>longidigitatus</i> , Ang.....								*			
<i>longimanus</i> , Ang.....								*			
<i>marcouanus</i> , W. & M.....	*		*								
<i>minor</i> , W. & S.....								*			
<i>moniliformis</i> , Mill.....									*		
<i>necis</i> , W. & M.....	*										
<i>nubilus</i> , Ang.....								*			
<i>ornatus</i> , Hall.....						*					
<i>pulcher</i> , McCoy.....									*		
<i>quinguangularis</i> , Ang.....								*			
<i>radiatus</i> , Ang.....								*			
<i>scanicus</i> , Ang.....								*			
<i>schultzeianus</i> , Ang.....								*			
<i>speciosus</i> , Hall.....							*				
<i>tennessensis</i> , Hall.....					*						
<i>umbrosus</i> , M. & G.....			*								
<i>urniformis</i> , S. A. M.....	*										
Petalocrinus, Weller.											
<i>angustus</i> , Bather.....								*			
<i>expansus</i> , Bather.....								*			
<i>inferior</i> , Bather.....		*									
<i>longus</i> , Bather.....			*								
<i>mirabilis</i> , Weller.....		*									
<i>visbyensis</i> , Bather.....								*			
Pisocrinus, De Kon.											
<i>baccula</i> , M. & G.....			*								
<i>benedicti</i> , S. A. M.....			*								
<i>campana</i> , S. A. M.....			*								
<i>gemmiformis</i> , S. A. M.....			*								
<i>globosus</i> , Ring.....							*				
<i>gorbyi</i> , S. A. M.....			*								
<i>milligani</i> , M. & G.....					*						
<i>ollula</i> , Ang.....								*			
<i>pilula</i> , DeKon.....								*	*		
<i>pyriformis</i> , Ring.....							*				
<i>pocillum</i> , Ang.....								*			
<i>tennessensis</i> , Roem.....					*						
Platycrinus, Miller.											
<i>corporiculus</i> , Ring.....							*				
<i>dubius</i> , Weller.....	*										
<i>siluricus</i> , Hall.....			*								

SPECIES	North. Ill. and Wis.	Iowa	Indiana	Kentucky	Tennessee	Ohio	New York	Gotland	England	Bohemia	Australia
Polypeltes , Ang.											
<i>granulatus</i> , Ang.								*			
Pycnosaccus , Ang.											
<i>costatus</i> , Ang.								*			
<i>nodulosus</i> , Ang.								*			
<i>ornatus</i> , Weller.	*										
<i>scrobiculatus</i> , His.								*			
Sagenocrinus , Ang.											
<i>expansus</i> , Phill.									*		
Scyphocrinus , Zenker.											
<i>elegans</i> , Zenker.										*	
Siphonocrinus , S. A. M.											
<i>armosus</i> , McCh.	*										
<i>nobilis</i> , Hall.	*										
<i>pentagonus</i> , W. & S.	*										
Stelidiocrinus , Ang.											
<i>capitulum</i> , Ang.								*			
<i>lævis</i> , Ang.								*			
<i>longimanus</i> , Ang.								*			
<i>ovalis</i> , Ang.								*			
Stephanocrinus , Con.											
<i>angulatus</i> , Con.							*				
<i>cornetti</i> , S. A. M.			*								
<i>elongatus</i> , S. A. M.			*								
<i>gemmiformis</i> , Hall.			*				*				
<i>hammelli</i> , S. A. M.			*								
<i>obpyramidalis</i> , S. A. M.			*								
<i>osgoodensis</i> , S. A. M.	*		*								
Streptocrinus , W. & S.											
<i>crotalurus</i> , Ang.								*			
Taxocrinus , Phill.											
<i>orbignii</i> , McCoy.									*		
<i>tuberculatus</i> , Mill.									*		
Thalamocrinus , M. & G.											
<i>cylindricus</i> , M. & G.					*						
<i>ovatus</i> , M. & G.					*						
Thenarocrinus , Bather.											
<i>callipygus</i> , Bather.									*		
<i>gracilis</i> , Bather.									*		
Thysanocrinus , Hall.											
<i>brachiatus</i> , Hall.							*				
<i>decadactylus</i> , Phill.									*		
<i>egani</i> , S. A. M.	*										
<i>halli</i> , Lyon.				*							
<i>icosidactylus</i> , Phill.									*		
<i>inornatus</i> , Hall.	*		*								
<i>interradiatus</i> , Ang.								*			
<i>lævis</i> , Ang.								*			
<i>liliiformis</i> , Hall.							*				
<i>lockportensis</i> , Ring.							*				
<i>milliganae</i> , M. & G.					*						
<i>occidentalis</i> , Hall.	*		*								
<i>ornatus</i> , Ang.								*			
<i>pentangularis</i> , Hall.	*							*			
<i>quinguangularis</i> , Schultz.								*			
<i>speciosus</i> , Ang.								*			
Zophocrinus , S. A. M.											
<i>howardi</i> , S. A. M.	*		*								

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— —, Revision of the Palæocrinoidea, Part III. Discussion of the classification and relations of the Brachiata Crinoids, and conclusion of the generic descriptions, Second Section. (Proc. Acad. Nat. Sci., Phil. pp. 64-226, 1886.)

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— —, The North American Crinoidea Camerata. (Mem. Mus. Comp. Zool., Harvard Coll., vols. XX-XXI, pp. 1-837, pls. 1-83, 1897.)

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DESCRIPTIONS OF GENERA AND SPECIES.

For most of the generic descriptions in this paper, the writer is in large part indebted to the publications of Wachsmuth and Springer and F. A. Bather. In no case, however, has a generic description been copied in its entirety without the introduction of minor changes, therefore they have not been treated as quotations.

Order I. INADUNATA.

Family I. CYATHOCRINIDÆ.

Genus I **CYATHOCRINUS** Miller.

Body, with the arms attached, elongate; the sides of the calyx usually convex and incurved above, giving to it a subglobular form.

Infrabasals five, equal, pentagonal, forming either a nearly flat disk or a shallow cup. Basals large, all hexagonal and angular above except the posterior one, which is heptagonal, being truncated



FIG. 33.—Diagram of *Cyathocrinus*.

distally for the support of the anal plate. Radials equal, as large or larger than the basals, incurving over the vault, articulating facet rarely occupying more than one-half the width of the plate, often less than one third, and from one third to one half, or even less, of its height. A single quadrangular anal plate rests upon the distal truncated edge of the posterior basal and between the two posterior radials. None of the succeeding plates in the series are included in the calyx, they being much smaller, and forming a part of the ventral sac.

Ventral disk composed of five large oral plates, which alternate with the radials and are joined to their incurved distal

margins; the space in the center between the orals filled with smaller plates. The food grooves and ambulacral canals arched over solidly by two rows of alternate covering plates. The ventral sac is composed of numerous small, irregularly arranged plates, extending to about one half the height of the arms.

Arms long, uniserial, bifurcating regularly several times, gradually tapering toward their tips; the ventral food grooves inclosed by a double row of alternating covering plates.

Cyathocrinus cora Hall, pl. xiv, figs. 6-10.

- 1868. *Cyathocrinus cora*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., p. 324, pl. xi, figs. 13-14.
- 1870. *Cyathocrinus cora*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., (Rev. Ed.), p. 366, pl. xi, figs. 13-14.
- 1879. *Cyathocrinus cora*. Wachsmuth and Springer, Rev. Palæocr., pt. I, p. 85.
- 1881. *Cyathocrinus cora*. Miller, Jour. Cinn. Soc. Nat. Hist., vol. IV, p. 174.

Dorsal cup large, more or less subglobular in form; proportional height somewhat variable, the height and width being nearly equal in some specimens, while in others the height is considerably greater than the width. All the specimens observed are internal casts, and these are always ornamented—though sometimes very faintly—with groups of parallel ridges which cross each suture of the dorsal cup at right angles, except those between the infrabasal plates; in these groups of ridges those near the center of the suture are the longest, those near the ends of the sutures being much shorter in order to accommodate the ridges crossing the adjacent sutures.

Infrabasals large, their distal ends angular, forming a widely spreading pentagonal cup with nearly straight sides. Basals five, very large, four of them hexagonal and one heptagonal; about as high as wide, sometimes somewhat constricted horizontally across the middle with a sort of rounded protuberance or node below the constriction. Radials large, more or less constricted at the arm bases; the distal portions between the arms curved abruptly inward toward the center of the ventral disk and forming five rounded interrarial protuberances; the arm bases are placed low down on the radials in a sort of notch between the interrarial protuberances which stand well up above them. A single large anal plate is in line with the radials, and rests upon the upper truncated face of the posterior basal.

The ventral disk unknown.

Casts of the proximal portions of the arms are present in a few specimens; from these casts, in proportion to the size of the calyx, the arms would seem to be very slender. Almost immediately on leaving the calyx they divide into two main divisions which reach out laterally in a nearly horizontal direction, and about parallel with the surface of the large radial plates; each of these primary horizontal divisions of the arms give off, along the upper side, several nearly vertical branches, there being three or more from each division in the width of the radial plates. In the posterior arms the main divisions toward the anal plate have a more vertical direction.

Remarks: The internal casts of this species are not uncommon in the Chicago fauna. One of its most characteristic features is the presence of the groups of parallel ridges crossing the sutures. Sometimes these ridges are very prominent, but in other specimens they are so faint that they can be observed only when held so that the light strikes them at a proper angle, but in all cases they are present. What may have been the function of these ridges, which were, of course, narrow grooves on the inside of the plates, has not been determined. They have much the appearance of the ridges on the internal casts of some cystideans, but in the absence of the plates it cannot be determined with certainty whether they were associated with pores piercing the plates, as in the cystidians, or not, but they seem not to have been so associated. The great variation in the size and prominence of the ridges, they sometimes being almost obsolete, would seem to indicate that they were not of vital importance to the crinoid.

The specimens of this species from Racine, Wis., illustrated by Hall, are much smaller than most of those observed from Chicago. There seems to be no difference between the Racine and Chicago specimens, however, save in size, and they are both, without doubt, members of the same species.

From other species of the genus, *C. corn* is distinguished by its large, robust calyx, with the interradianal protuberances between and above the arm bases, and by its slender and curiously branching arms. With more perfect material, preserving the external characters and the arms, it might be found necessary to separate this species from the genus *Cyathocrinus*.

Localities—Bridgeport and Joliet.

Cyathocrinus vanhornei Miller, pl. xiv, fig. 5.

1881. *Cyathocrinus vanhornei*. Miller, Jour. Cinn. Soc. Nat. Hist., vol. IV, p. 261, pl. vi, fig. 3.

1886. *Cyathocrinus Van Horni*. Wachsmuth and Springer, Rev. Palaeocr., pt. III, p. 266.

Dorsal cup, in the casts, about as high as wide, greatly constricted at about the median line and curved inward along the distal margin except on the posterior side, which is protuberant.

Infrabasals five, rather large, forming a saucer or shallow cup-shaped cup. Basals large, a little higher than wide; four of them hexagonal, and one, the posterior, heptagonal; the proximal half of the plates is nearly vertical or slightly spreading, the distal portion is bent abruptly outward, forming a marked constriction of the calyx at about the middle of the basals. Radials large, the distal portion of them curving inward toward the center of the ventral disk; the arm bases placed rather low down on the plates. Anal plate in line with the radials, but smaller than those plates, followed by two plates which, in some specimens, seem to be partially included in the calyx at their proximal ends; the anal side protuberant between and above the radials.

Ventral disk, arms and column unknown.

Remarks: This species can be easily recognized by its peculiar, constricted calyx. All of the specimens examined have been internal casts, but Miller's type specimen preserved the plates, which are described by him as being entirely smooth. The specimen here illustrated is somewhat abnormal on the posterior side, not shown in the figure. The posterior basal is much reduced in size and is crowded upward, so that it is not in contact with the underbasals; it is quadrangular in form and is placed obliquely between the two posterior lateral basals below and the right posterior radial and the anal above, having exactly the position of a radianal, and the anal plate rests upon both this misplaced plate and the basal to the left of it. This abnormal development of the basals gives to the specimen a slightly more constricted appearance than most of the others; but not much, because the four basals which preserve their normal position are somewhat increased in width.

This species may be always distinguished from *C. cora* by its constricted calyx, its smaller size, and by the absence of the groups of parallel ridges crossing the sutures.

Locality—Bridgeport.

Cyathocrinus turbinatus, n. sp., pl. xiv, fig. 13.

Dorsal cup, in the casts, turbinate, about as high as wide, rounded below, strongly and abruptly constricted just below the arm bases, and slightly constricted at the middle of the radials.

Infrabasals small. Basals large, higher than wide, four of them hexagonal, and one, the posterior one, heptagonal; the plates slightly constricted horizontally at about the median line, ornamented with radiating ridges which pass from a node in the center, across the sutures, toward the centers of the adjoining plates; there are four stronger ridges which pass from the basals to the infrabasals and radials, with fainter ones between. Radials large, abruptly constricted horizontally just below the arm bases; the arm bases prominent and generally represented in the casts by two horizontally flattened projections situated one above the other. The spaces between the arm bases flattened or concave. Anal plate of medium size, protuberant, placed in line with the radials and supported by the truncated posterior basal.

Remarks: This species is known only from the internal casts, but can be easily distinguished from the associated species of the genus by the peculiar contraction of the calyx below the arm bases. It is, of course, impossible to compare the species with others in which the plates are preserved.

Locality—Chicago.

Genus 2 **BOTRYOCRINUS** Angelin.

Dorsal cup, cup-shaped, or broadly obconical with a truncated base, the plates of medium thickness; the symmetry destroyed by the introduction of both an anal and a radial plate.

Infrabasals five, slightly protuberant. Basals five, three of them equal, the other two of somewhat different form because of the introduction of the

anal and radial plates in the calyx. Radials large, articulating facets for the arms, concave, occupying from one half to three fourths of the width of the plates. Radial plate quad-



FIG. 34.—Diagram of *Botryocrinus*.

angular, smaller than any of the other plates of the calyx, lying between the posterior and right postero-lateral basals, the right posterior radial and the anal plates. Anal plate of similar form and nearly as large as the radials, and lying in line with them.

The ventral disk unknown. The ventral sac one half to two thirds as long as the arms, curved upon itself toward the summit, composed of regular hexagonal plates.

Arms uniserial, with two—rarely three or four—main branches, bearing armlets or pinnules.

Botryocrinus polyxo Hall, pl. xiv., fig. 12.

1863. *Cyathocrinus Polyxo*. Hall, Trans. Albany Inst., vol. IV, p. 199.

1879. *Cyathocrinus Polyxo*. Hall, 28th Rep. N. Y. State Mus. Nat. Hist., p. 135, pl. xv, figs. 10-17.

1879. (?) *Cyathocrinus polyxo*. Wachsmuth and Springer, Rev. Palæocr., pt. I, p. 87.

1882. *Cyathocrinus Polyxo*. Hall, 11th Rep. Geol. Nat. Hist., Ind., p. 264, pl. xiv, figs. 10-17.

1886. *Homocrinus polyxo*. Wachsmuth and Springer, Rev. Palæocr., pt. III, p. 220.

1893. *Botryocrinus polyxo*. Bather, Crin. Gotland, pt. I, p. 105.

Dorsal cup turbinate, truncated below; surface of the plates smooth. The plates generally slightly prominent in the center, with low angular ridges, sometimes almost obsolete, extending to the sutures, with the intermediate spaces flattened or depressed.

Infrabasals of medium size, pentagonal, wider than high, the proximal margins extending slightly beyond the column. Basals large, wider than high, three of them hexagonal, the two posterior ones heptagonal because of the presence of the radianal and anal plates in the calyx. Radials large, wider than high, the articulating facets for the arms comparatively small and indenting the plates to about one-fourth of their depth. Radianal plate quadrangular, with nearly equal sides, placed obliquely between the two posterior basals below and the right posterior radial and the anal plate above. Anal plate large, resting upon truncated distal side of the posterior basal and the radianal, and placed between the two posterior radials.

Ventral disk and arms unknown.

Remarks: The Chicago specimens of this species are indistinguishable from typical individuals from Waldron, Ind., The species is one of the less common ones in the Chicago fauna, but differs from most of its associates in generally

being preserved with the plates partly or wholly complete, the internal casts being less abundant than the more perfectly preserved specimens.

Locality—Bridgeport.

Genus 3 AMPHERISTOCRINUS Hall.

Dorsal cup, cup or urn shaped. The symmetry destroyed by the introduction of both an anal and a radial plate in the calyx.

Infrabasals three, two of them equal, with truncated distal sides, the right postero-lateral one one half as large as the other two, angular above. Basals five, large, the two resting upon the two larger underbasals, pentagonal; the two alternating with these, hexagonal; and the posterior one, which is truncated distally for the support of the anal plate, heptagonal. Radials smaller than the basals, pentagonal; the articulating facets for the arms small, semicircular. Radial plate large, pentagonal. The anal plate in line with the radials, resting upon the truncated distal face of the posterior basal, and between the radial and right posterior radial on one side, and the left posterior radial on the other.

The vault and arms unknown.

Ampheristocrinus dubius, n. sp., pl. xiv, fig. 11.

Only known from an internal cast. Dorsal cup higher than wide, with convex sides; pointed below and contracted above, the greatest diameter at the proximal angles of the radials.

Infrabasals three, two large pentagonal ones of equal size with arcuate distal sides, and one small, quadrangular one half as large as the others; the small plate situated below the right posterior radial. Basals large, higher than wide, two of them pentagonal, two hexagonal, and one heptagonal. Radials smaller than the basals, widest along the proximal sides; four of them about as high as wide, angular below and resting upon the basals; the right posterior one much shorter and smaller than the others, straight along the proximal side and resting upon the large radial plate, and not in contact with the basals. Radial plate very large, pentagonal, angular,



FIG. 35.—Diagram of *Ampheristocrinus*.

below, placed directly underneath the right posterior radial, and resting upon the distal sloping sides of the posterior and right postero-lateral basals, in contact laterally with the right antero-lateral radial on one side and with the anal plate on the other. Anal plate a little smaller than the radianal, higher than wide, in line with the radials and resting upon the truncated distal side of the posterior basal.

Ventral disk, arms and column unknown.

Remarks: This species is peculiar in having but three underbasals, a characteristic of but few Inadunate crinoids, and it is placed in Hall's genus *Ampheristocrinus* chiefly on account of this character. In *A. typus*,* from Waldron, Ind., the only other species of the genus, the radianal plate is not so large as in this one, and it is not placed directly below the radial plate, but lies between the right posterior radial and the anal plate.

Locality—Romeo.

Family II. HETEROCRINIDÆ.

Genus 4 MYELODACTYLUS Hall.

In habit of growth this genus differs from all other crinoids, so far as known. The calyx, with the arms attached, is very small and elongate, with the stem coiled about it in a plane. At or before the completion of the first coil the stem recurves upon itself, and the remaining portion is coiled in the opposite direction, entirely surrounding the crown.

The base is monocyclic. Basals five, irregular in size and position. Radials five, all (?) except the left posterior one divided horizontally. The anal plate rests upon the upper sloping side of the right posterior interrarial, and partly abuts against the left posterior radial and the right posterior super-radial.

Ventral tube long and narrow.

Stem, in the proximal region, evolute, more or less circular in section; in the distal region involute, compressed or sub-crescentic in section, with two rows of cirri varying in arrangement.

Remarks: The genus *Myelodactylus* was first described by Hall† in 1852, and has been frequently recognized since that time both in America and in Europe; but not until 1893, was the true relationship of the genus first pointed out by Bather‡.

*Eleventh Ann. Rep. Geol. Nat. Hist., Ind., p. 278 (1882).

†Pal. N. Y., Vol. II, p. 191.

‡The Crin. of Gotland, Pt. I, Crin. Inad., p. 36.

The adoption by the latter author, however, of Salter's name *Herpetocrinus*, published in 1873, instead of Hall's, seems to be unfounded. Although Hall believed that the specimens he described were crinoid arms instead of the stems, as later investigation has proved, his illustrations and descriptions were such that his fossil could not be mistaken, and therefore his name, having priority, should stand. Furthermore, the bodies of these crinoids are so uncommon that the characters of the stems, just those characters illustrated by Hall, have to be used for specific determination.

Myelodactylus bridgeportensis Miller, pl. xv, figs. 1-2.

1880. *Myelodactylus bridgeportensis*. Miller, Jour. Cinn. Soc. Nat. Hist., vol. III, p. 141, pl. iv, figs. 1-10.

The body of this species is preserved in one of the type specimens, but it is so incrustated with fine crystalline particles that the details of its structure cannot be made out. All of the specimens are, to a great extent, casts, so that in no case can the characters be determined with entire satisfaction.

The stem is slender and closely coiled; the proximal portion for about one complete coil is evolute, it then turns abruptly upon itself and the remaining coils are involute. The stem increases in size distally, and the cross-section becomes more and more semilunar; the most rapid increase in size is just after the stem recurves on itself and becomes involute. In the specimen best preserved to show the inner coils of the stem there are fully two complete involute coils before the stem ossicles begin to bear cirri; in the outer coils each ossicle apparently bears a pair of slender, tapering cirri, one on either side, which reach almost or entirely to the center of the coil.

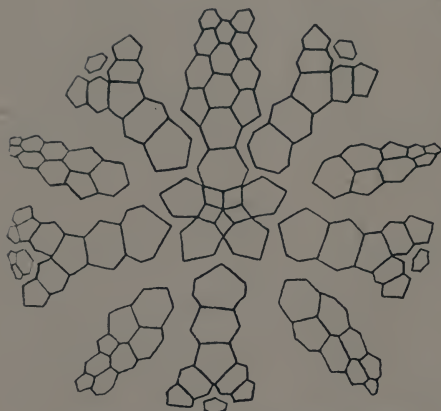
Remarks: Although the specimens of this species in the dolomitic Niagaran limestone of northern Illinois are so poorly preserved that all their characters cannot be made out with entire satisfaction, there is little or no doubt of their constituting a good species. The most characteristic feature of the species is its slender and remarkably closely coiled stem. The cirri also are given off very symmetrically, and they differ from most of the Swedish specimens illustrated by Bather in being gently tapering, with straight sides, not being constituted of minute bead-like joints.

Locality—Bridgeport.

Order II. CAMERATA.

Family III. THYSANOCRINIDÆ.

Genus 5 THYSANOCRINUS Hall.

FIG. 36.--Diagram of *Thysanocrinus*.

Calyx subglobose, urn or bell shaped, the rays marked by more or less conspicuous ridges; the surface of the plates smooth, or variously ornamented. Infrabasals five, small, barely extending beyond the column, or entirely hidden by it. Basals five, four of them equal and angular above; the fifth truncated and supporting a large anal plate.

Radials considerably larger than the costals, their proximal sides distinctly angular, the lateral faces comparatively short. Costals two. Distichals two or three in each series. In some cases palmars are also present, the axillary distichal giving rise on the interrarial side to an armlet for the most part included in the calyx and on the other side to the main arm. Four of the first interbranchials large, angular below, resting upon the sloping upper corners of the two radials and against the costals; two plates in the second row, often followed by smaller ones above which connect with the plates of the disk. The anal side considerably wider, the first plate large, hexagonal, resting upon the truncated posterior basal, three plates in the second row and smaller ones above. In some species an uninterrupted row of anal plates extends to the anal opening. Interdistichals generally represented and rather large. Column round or obtusely pentangular.

***Thysanocrinus pentangularis* Hall, pl. i, figs. 8-11.**

1867. *Glyptaster pentangularis*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., p. 326, pl. x, fig. 4.
 1867. *Melocrinus verneuili*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., p. 327, pl. x, fig. 5. (Not *Actinocrinus verneuili*, Troost, 1849.)
 1870. *Glyptaster pentangularis*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., Rev. Ed., p. 369, pl. x, fig. 4.

1870. *Melocrinus verneuili*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., Rev. Ed., p. 372, pl. x, fig. 5.
1881. *Glyptaster pentangularis*. Wachsmuth and Springer, Rev. Palæocr., pt. II, p. 196.

Dorsal cup pentangular, obpyramidal, truncate below. The brachial series stand out as prominent rounded ridges, the interbrachial and interdistichal areas depressed. Surface of the plates smooth.

Infrabasals small, only their distal points visible beyond the column. Basals large, their lower margins thickened and expanded into nodes which stand out on a level with the top stem joint, forming a marked pentalobate rim around it. The node on each plate gives rise distally to two conspicuous rounded ridges, which extend upward to the conspicuous central nodes of the two adjacent radials. Radials about equal to the basals in size, as wide or wider than high, marked by two prominent rounded ridges below, which extend from the centers of the two adjacent basals to the centers of the radials, where they unite and continue upward along the costals to the first axillary plates, where they divide, one branch following each division of the rays. First costals hexagonal or quadrangular, dependent upon the size of the first interbrachials, wider than high, smaller than the radials. Second costal pentagonal, about as large as the first. Distichals two or three in each series, the axillary plate giving rise on the interradiar side to an armlet included for the most part in the calyx, and on the inner side to the main division of the arm. First interbrachials as large as the first costals and sometimes reaching to the tops of those plates, followed by two smaller plates in the second row, one large or two smaller plates in the third row, and smaller plates in the succeeding rows. Interdistichals generally three in number, the first one being the larger. Anal interradius wider than the others; divided longitudinally by a row of plates not elevated above those on either side, in which all are hexagonal except the first, which is sometimes octagonal; the plates on each side of the median row are smaller and fewer in number than in the regular interbrachial areas.

Ventral disk flat, composed of a large number of small, irregular, polygonal plates; the plates covering the ambulacra not differing from the interambulacral plates and not elevated above them. Anal opening large, situated about half way between the center of the disk and the posterior margin, open-

ing directly through the vault, with no protuberance or proboscis.

Arms unknown.

Remarks: The internal casts of this species are common in the Bridgeport collections, but specimens with the plates preserved, or good natural moulds, are rare. There can be no doubt that the internal cast from Racine, Wis., described by Hall as *Glyptaster pentangularis*, is identical with these Bridgeport specimens, and the specimen described by him from the same locality as *Melocrinus verneuili* is apparently but a smaller specimen of the same species, with a slightly narrower base, in which the infrabasal plates are probably not recognizable, as is often the case in these internal casts. The Bridgeport specimens have sometimes been identified as *T. inornatus*, but they are entirely distinct from that species, both as described by Hall from Waldron, Ind., and by Wachsmuth and Springer from St. Paul, Ind. From the Waldron specimens those from Bridgeport differ in the absence of the somewhat coarsely radiating ridges upon the plates of the dorsal cup. From the St. Paul specimens, which possibly belong to a species distinct from the Waldron *T. inornatus*, the Bridgeport specimens are distinguished by their flatter and more depressed interbrachial areas, by their more conspicuous brachial ridges, and by the perfectly flat ventral disk upon which the ambulacral plates are not elevated in prominent ridges.

In the internal casts the line of the radial and brachial plates is marked by a well-defined angle, but not by the elevated rounded ridges of the exterior, so that in these specimens the interbrachial areas are nearly flat, the spaces between the middle of each two adjacent rays being nearly in a plane, except near the arm bases, where the spaces are depressed between the arms. In these specimens, when well preserved, the sutures between the infrabasal plates are marked by elevated ridges, so that the base of the cup has the appearance of being ornamented by a raised, five-pointed star.

The specimens of *T. pentangularis* exhibit considerable variation in the amount of divergence of the sides of the dorsal cup upward from the base, and one specimen shows an abnormal variation of the posterior interbrachial area, the two posterior radials being in lateral contact, with the first anal plate resting upon their two upper lateral sloping sides and not upon the truncated distal side of the posterior basal.

Localities—Bridgeport and Hawthorn.**Thysanocrinus occidentalis** Hall, pl. i, figs. 6, 7.

1863. *Glyptaster occidentalis*. Hall, Trans. Albany Inst., vol. 4, p. 204.
 1867. *Glyptaster occidentalis*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., p. 326, pl. x, fig. 3.
 1870. *Glyptaster occidentalis*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., Rev. Ed., p. 369, pl. x, fig. 3.
 1879. *Glyptaster occidentalis*. Hall, 28th Rep. N. Y. State Mus. Nat. Hist., p. 133, pl. xiii, figs. 7-11.
 1881. *Glyptaster occidentalis*. Wachsmuth and Springer, Rev. Palæocr., pt. II, p. 196.
 1882. *Glyptaster occidentalis*. Hall, 11th Rep. Geol. and Nat. Hist. Surv., Ind., p. 262, pl. xii, figs. 7-11.
 1897. *Thysanocrinus occidentalis*. Wachsmuth and Springer, N. A. Crin. Cam., vol. I, p. 194, pl. xviii, figs. 5a, b, c.

Dorsal cup pentangular, obpyramidal, rounded below; the brachial series standing out as prominent rounded ridges; the interbrachial and interdistichal areas depressed. Surface of plates ornamented by delicate ridges radiating from their centers.

Infrabasals small, only their distal points visible beyond the column. Basals large, their lower margins thickened and expanded into nodes. The node on each plate gives rise distally to two conspicuous rounded ridges, which extend upward to the central nodes of the two adjacent radials. Radials about equal in size to the basals, as wide or wider than high, marked by two prominent rounded ridges below, which extend from the centers of the two adjacent basals to the centers of the radials, where they unite and continue upward along the costals to the first axillary plates, where they divide, one branch following each division of the rays. First costals hexagonal, as wide or wider than high, smaller than the radials. Second costals pentagonal, about as large as the first. Distichals two or three in each series. First interbrachials as large as the first costals, followed by two smaller plates in the second row, and still smaller ones above. Interdistichals about three in number, the first plate being the larger. Anal interradius wider than the others, divided longitudinally by an elevated row of hexagonal plates. The plates on either side of the median ridge are smaller and fewer in number than in the regular interbrachial areas.

Ventral disk unknown. Arms unknown, apparently two from each ray.

Remarks: The internal casts of this species may be distin-

guished from those of *T. pentangularis* by their more rotund and less angular form, and also by the elevated row of anal plates in the posterior interradius. In general form, proportions, and ornamentation, the Bridgeport specimens are not materially different from the typical *T. occidentalis* from Waldron, but they do differ from the descriptions of that species in the possession of an elevated row of anal plates in the posterior interradius, a character which is said by Wachsmuth and Springer to be absent from this species.

Localities—Bridgeport and Hawthorn.

Thysanocrinus egani Miller, pl. i, fig. 5.

1881. *Glyptaster egani*. Miller, Jour. Cinn. Soc. Nat. Hist., vol. IV, p. 261, pl. vi, figs. 4-4b.

1885. *Glyptaster Egani*. Wachsmuth and Springer, Rev. Palæocr., pt. III, p. 101.

Dorsal cup small, pentangular obpyramidal, truncate below. Plates protuberant.

Infrabasals minute, almost covered by the column. Basals large, protuberant, flattened in the center, beveled at the margins to the sutures, which are situated in deep depressions. Radials the largest plates in the dorsal cup, protuberant, beveled to the sutures except at the distal end, which is the most elevated part of the plate, and forms the beginning of a flattened angular ridge which follows the brachial series. First costals quadrangular or pentagonal, wider than high, elevated along the longitudinal median line, beveled laterally to the sutures; second costals pentagonal or hexagonal, higher than wide, elevated in the center, beveled laterally to the sutures. Two or three distichals preserved in the type specimen, elevated along the longitudinal median line, beveled at the sides. First interbrachials elevated, nearly as large as the radials, reaching up to or a little above the proximal ends of the second costals, flat in the center, beveled all around the margin to the bounding suture, followed by two much smaller protuberant plates in the second row, and two still smaller ones in the third. In the posterior interradius is a protuberant anal plate somewhat larger than the regular first interbrachials, apparently followed by three smaller protuberant plates in the second row. A single small interdistichal is present, which is elevated and has the beveled margins of the other plates, but the center of the plate is not so high as the adjacent distichals.

Ventral disk and arms unknown.

Remarks: This species is represented by several specimens from Bridgeport in the Academy of Science collection. They differ from the associated species of the genus in their much smaller size, and in their peculiar protuberant plates, which are beveled on the margins in such a way that all the sutures except the transverse sutures of the rays are situated in rather deep angular depressions. The species also differs from its associates in the almost entire absence of the conspicuous angular ridges which mark the basals and radials in *T. occidentalis* and *T. pentangularis*. It is possible that this species is but the young of one of the other species, but a much larger series of specimens than are available would be necessary to establish this fact. This species is not recognized by Wachsmuth and Springer in their recent monograph, but is considered a young form.

Locality—Bridgeport.

Genus 6 **CYPHOCRINUS** S. A. M.

Calyx depressed, wheel-shaped, the sides of the dorsal cup expanding rapidly to the second costals, beyond which they bend outward and downward in the radial areas so that the arms are pendant. Infra-basals five, small. Basals five, four of them equal and angular at the distal end, the posterior one truncated by the anal plate. Radials comparatively small, the two posterior ones hexagonal, the other three heptagonal. Costals two, the first one very short; the axillary costal followed by distichals. Arms stout, pendent, sending off lateral armlets. First interbranchials of the regular sides very large, reaching up beyond the costals, succeeded by several rows of small plates. Anal plate resting upon the truncated distal end of the posterior basal, and rising above the radials, supporting two or three much smaller plates and others above. Ventral disk depressed, the anal opening eccentric and situated at the top of a large protuberance.



FIG. 37.—Diagram of *Cyphocrinus*.

Remarks: The genera *Cyphocrinus* and *Hyptiocrinus* were described by S. A. Miller, and by Wachsmuth and Springer respectively, almost contemporaneously, from material col-

lected at the same locality, and representing the same species. Wachsmuth and Springer's description was published in the September (1892) number of the *American Geologist*. The "Advance Sheets from the Eighteenth Report of the Geological Survey of Indiana," in which Miller's description is published, also bears the date September, 1892, and Miller* has given evidence that numerous copies of the paper were mailed from Indianapolis on September 1, although it is very possible that Wachsmuth and Springer did not secure a copy until October 26, the time they give in their monograph as the date of publication of Miller's paper. I have not been able to learn from the publishers of the *American Geologist* the exact date of distribution of the September number of that journal in 1892, but Miller* states that he received that number on September 11, thus making its date of mailing at Minneapolis September 9; in any event the date of distribution was not earlier than September 1, and it may have been some days later.

Because of the almost exact coincidence in the dates of publication of the two names, it is difficult to decide, on the grounds of priority, which one should stand, but under the circumstances, when we consider that Wachsmuth and Springer's description was unaccompanied by illustrations, while Miller's was accompanied by fairly well executed illustrations, and was published at least as early as the other, it seems best to adopt the name *Cyphocrinus*. Furthermore, that Miller had the better material from which to describe the new genus is shown by the fact that in their monograph Wachsmuth and Springer copy one of Miller's figures to show the characters of the dorsal cup, which they would not have done had they possessed the proper material for illustration in their own collection.

Cyphocrinus chicagoensis, n. sp., pl. i, figs. 1-4.

Calyx wheel-shaped, from one to one and one-half times as wide as high; deeply depressed between the arms; dorsal cup and ventral disk about equal in height; the plates of the dorsal cup smooth, those of the vault nodose or convex.

Dorsal cup broadly obconical to the top of the costals, then bending outward and downward in the brachial portions. Basals, radials, and costals ornamented with a longitudinal ridge following the median line of the plates.

Infrabasals small, the sutures between them in the internal

*Second Appendix to North American Geology and Palæontology, October, 1897, p. 719.

casts marked by five rounded ridges radiating from the center of the base like the rays of a star. Basals rather large, bending abruptly upward, four of them about as wide as high, the posterior one higher than wide, truncated distally. Radials larger than the basals, the two posterior ones hexagonal, the other three heptagonal, much wider than high, their proximal ends distinctly angular, in contact laterally except in the posterior interbrachial area. First costal rectangular, shorter and narrower than the radials, twice as wide as high. Second costals a little higher and wider than the first, pentagonal, the upper sloping sides meeting at a right angle or at more than a right angle. Form and proportion of distichals not distinguishable. First interbrachials the largest plates in the calyx, extending beyond the costals between the distichals, the succeeding plates not distinguishable. Anal plate nearly as large as the interbrachials, resting between the radials and costals of the posterior rays upon the truncated distal end of the posterior basal, supporting two plates in the second row between the distichals of the posterior rays. Plates beyond these indistinguishable. Interdistichals present, but their size, form, and number indistinguishable.

Ventral disk covered by numerous small, irregular plates, not distinctly recognizable upon the cast, those above the arm bases nodose. The ambulacral grooves in the casts are represented as radiating rounded ridges, which bifurcate once upon the main portion of the vault, each main branch giving off several smaller lateral branches from alternate sides before the arms become wholly free from the calyx.

Two arms from each ray, each giving rise to lateral armlets, the first ones being apparently given off before the arm is wholly free from the calyx.

Remarks: This species seems to be constant in the characters of its general form and proportions, but only rarely can the outlines of the plates of the dorsal cup be distinguished. The species shows considerable variation in size, the forms illustrated being among the largest which have come under observation. In one specimen, belonging to the Field Columbian Museum, there is a remarkable bulging of the vault in the posterior interambulacral area into a dome-like protuberance, in the summit of which the anal opening is situated, a feature not observed in any other specimen. This species apparently differs from *C. gorbyi* in its larger size and in the

manner of branching of the arms before becoming free from the calyx.

Locality—Bridgeport.

Genus 7 **GAZACRINUS** S. A. M.

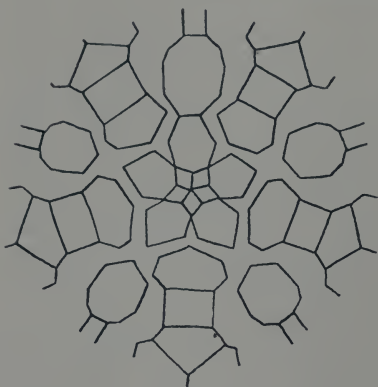


FIG. 38.—Diagram of *Gazacrinus*.

Calyx obconical or subglobose, truncated below. Infrabasals five, small, placed at the bottom of a deep basal concavity and completely hidden by the column. Basals five, large, the posterior one truncated by the anal plate; the proximal portions forming with the underbasals the sides of the basal excavation; the distal portions sharply recurved and extending upward and outward.

Radials as large or larger than the basals, wider than high; three of them heptagonal, the two adjoining the anal side hexagonal. Costals two, wider than high; the first quadrangular and the second pentangular, with the distal angle obtuse. Distichals two in the calyx, short. Interbranchial areas occupied by a single large plate or by one large one below and a smaller one above. Ventral disk covered by a large, probably anchylosed oral pyramid, the interambulacral spaces occupied by single plates, of which the posterior one is perforated by the eccentric anus. The ambulacra tegminal.

Remarks: The two names, *Gazacrinus* and *Idiocrinus*, were proposed for this genus by Miller and by Wachsmuth and Springer under the same circumstances and in the same publications as were *Cyphocrinus* and *Hyptiocrinus*. Miller's definition is by no means so clear, in some respects, as is that of Wachsmuth and Springer, because he did not recognize the dicyclic base, but his definition is accompanied by illustrations and seems to have priority, so it is adopted.*

Gazacrinus major, n. sp., pl. iii, figs. 1-2.

Calyx large, an inch or more in height. Dorsal cup obconical, truncated below, and somewhat constricted below the

*For a discussion of the priority of these names the reader is referred to the remarks under the genus *Cyphocrinus*, pages 75 and 76.

arm bases, with a deep basal excavation. Plates smooth, without ornamentation, and flat except for an ill-defined radial ridge.

Infrabasals small, constituting the bottom and a small portion of the sides of the basal concavity. Basals large and elongate, the proximal ends bending abruptly inward and forming the greater part of the sides of the basal concavity; the margin of the basal concavity forming a sharp edge around the bottom of the calyx; the exposed parts of the plates rising a little higher than the bottom of the basal excavation. Radials about one and one-half times wider than high, obscurely angular along the median line; the two posterior plates hexagonal, being truncated laterally by the anal, the others heptagonal. First costals nearly one half the size of the radials, quadrangular, about one and one-half times as wide as high, obscurely angular along the median line; second costal pentagonal, about equal to the first in size. First distichals nearly twice as wide as high, one half as wide as the costals. Higher plates of the rays unknown. Interbranchials two, the first one large, resting upon the sloping sides of adjacent radials and extending up to the first distichals; the second much smaller, apparently quadrangular, separating the distichals of adjacent rays. Anal plate similar to the other first interbranchials, but resting upon the truncated distal end of the posterior basal, followed by a quadrangular plate similar to the other second interbranchials.

Arms and vault unknown.

Remarks: This is the largest species of the genus as yet described, all four of the species of *Idiocrinus* recognized by Wachsmuth and Springer being much smaller. The species also differs from the definition of that genus as given by its authors, as well as from the original definition of *Gazacrinus*, in the presence of the small second interbranchial, though in the illustrations of *I. immaturus** such a plate is apparently represented. The ventral structure of *G. major* has not as yet been observed, but it doubtless conforms to that of the other species. In the internal casts of the species the base is broader, with a shallower and more rounded concavity.

In its general contour and in the basal excavation *G. major* has much in common with *Eucalyptocrinus crassus*, and it has been seen in some collections labeled as *Eucalyptocrinus*, but the arrangement of the plates in the two genera is entirely different.

Locality—Hawthorn.

*N. Am. Crin. Cam., pl. xviii, fig. 10.

Gazacrinus minor, n. sp., pl. iii, figs. 3-4.

Calyx small, subglobular. Sides of the dorsal cup flaring outward from the truncated base to the tops of the radials, above which they bend inward to the arm bases.

Infrabasals minute, situated in the bottom of the basal concavity. Basals elongate, the proximal ends bending inward and forming the sides of the basal concavity, the exposed parts rising a little higher than the bottom of the concavity, angular above except on the posterior side where the plate is truncated by the anal. Radials the largest plates in the calyx, wider than high. First costals small, about twice as wide as high; the second about the size of the first. The succeeding plates not observed. Interbrachial spaces filled by a single plate, that on the posterior side resting upon the truncated posterior basal, the others resting upon the sloping sides of the radials.

Arms and vault unknown.

Remarks: This species, which is only known from internal casts, is much smaller than *G. major*, figure 3 on plate iii being the largest one observed. Besides its smaller size it differs from the last species in the contraction of the sides of the dorsal cup above the radials and in the apparent absence of the small second interbrachial plate, though the presence or absence of such a plate cannot be certainly determined in the specimens which have come under observation.

Locality—Bridgeport.

Genus 8 LAMPTEROCRINUS Roemer.

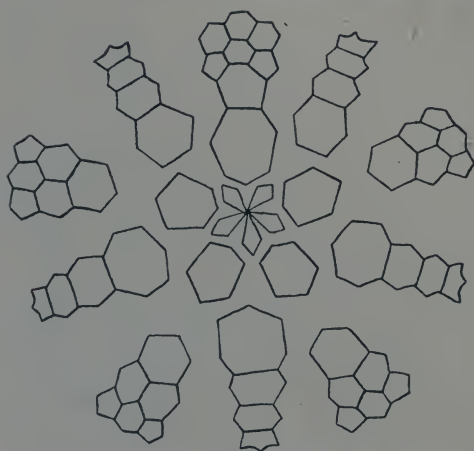


FIG. 39.—Diagram of *Lampterocrinus*.

Calyx unsymmetrical, obpyramidal, the rays formed into tubular appendages bearing the arms. Ventral disk greatly inflated posteriorly, and extended into a large tube, pushing the center of radiation to the anterior side of the calyx.

Infrabasals forming a large spreading

cup. Basals five, large, four of them equal and angular above; the posterior one considerably higher and truncated at the upper face. Radials very large. Costals two, the first hexagonal, the second either supporting two series of distichals or on one side a lateral arm and on the other the distichals. The higher orders of brachials are curved like arm plates, and with the covering plates form a rigid tube, from which small arms are given off alternately at intervals. Interbrachials large, passing uninterruptedly from the dorsal cup into the ventral disk; one plate in the first row followed by two in the second. At the anal side, which is somewhat wider, the first anal plate rests upon the basals and supports three small plates in the next range, which are succeeded by three plates and others above.

Ventral disk asymmetrical, strongly bulging at the posterior side and supporting a large central tube.

Lampterocrinus inflatus Hall, pl. ii, figs. 2-3.

1861. *Balanocrinus inflatus*. Hall, Rep. of Progress, Geol. Surv., Wis., p. 22.
 1867. *Lampterocrinus inflatus*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., p. 328, pl. x, fig. 6.
 1870. *Lampterocrinus inflatus*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., Rev. Ed., p. 374, pl. x, fig. 6.
 1881. *Lampterocrinus inflatus*. Wachsmuth and Springer, Rev. Palæocr., pt. II, p. 201.

Calyx elongate, decidedly asymmetrical. Dorsal cup higher than wide, spreading abruptly below, but more gently above, the greatest width being attained only at the arm bases. Arm bases prominent. External ornamentation of the plates not known, as the species has only been observed as internal casts.

Infrabasals five, forming a shallow, spreading cup, the sutures in the casts represented by elevated ridges. Basals large, as high or higher than wide, four of them angular above, the posterior plate higher than the others and truncated by the first anal plate. Radials as large or larger than the basals, three of them heptagonal, the two posterior ones hexagonal. First costals hexagonal, about half as large as the radials; second costals smaller than the first, bending outward to form the beginning of the underside of the tubular arms, followed by two series of distichals, the first of which stand out nearly at right angles to the calyx, and with the covering plates forming the bases of the tubular arms. First interbrachials as large or larger than

the first costals, hexagonal in outline, and followed by two smaller plates in the second row, and other smaller ones above, which pass imperceptibly into the vault. First anal plate much larger than the regular first interbrachials, higher than wide, followed by three plates in the second row, the middle one of which is greatly elongated, being more than twice as high as the two lateral plates.

The ventral disk one half as high as the dorsal cup, greatly inflated posteriorly, the center of radiation of the ambulacra crowded toward the base of the anterior arm. In the casts the ambulacra are represented by five radiating, elevated ridges. The interambulacral spaces filled with small plates which are continuous with the interbrachial plates of the dorsal cup.

The arms are pendent tubular extensions of the body.

Remarks: This species is not an uncommon one, but it has only been observed as internal casts. The specimen illustrated by figure 3 is the largest one that has been seen, the smaller specimen, figure 2, preserving the casts of the pendent tubular arms, is about the average size.

Localities—Bridgeport and Romeo.

Lampterocrinus robustus, n. sp., pl. ii, figs. 4-5.

Calyx short and broad, asymmetrical. Dorsal cup as wide or wider than high, the sides spreading rather rapidly to the prominent arm bases, where it is the widest. Surface of all the plates ornamented with central nodes and radiating ridges, the ridges extending from the basals to the radials and then along the median line of the rays being the sharpest and most pronounced; the ridge extending from the posterior basal along the line of anal plates somewhat less prominent than the radial ridges, and the remaining radiating ridges still less well defined. The ventral disk about as high as the dorsal cup, broad, dome-shaped, inflated posteriorly, the inflation leading up to a rather large anal tube. The plates of the ventral disk ornamented with small central nodes, but with no radiating ridges.

Infrabasals five, forming a shallow, spreading cup. Basals large, about as wide as high, four of them pointed above, the posterior one truncated by the first anal plate. Radials larger than the basals, generally much wider than high. First costals hexagonal, wider than high; second costals nearly as large as the first, bending outward at their distal extremities and supporting two series of distichals which form the under side of the tubular arms. First interbrachials as wide as high, followed

by two plates in the second row nearly as large as the first, and these followed by smaller plates which pass imperceptibly into those of the ventral disk. First anal plate larger than the regular first interbranchials, higher than wide, supporting three plates in the second row, the middle one of which is elongate, being twice as high as the two lateral plates.

Arms unknown beyond their bases, which are very large and prominent; from the direction of the bases they were probably pendent.

Remarks: This species differs from the last in its larger size, its shorter and broader form, its relatively much higher ventral dome and much larger arms. The wax impression of the exterior, illustrated in figure 5, is a narrower specimen than figure 4, but the internal cast, which is also preserved, shows the two to be the same species.

Localities—Romeo, Lemont, and Joliet.

Lampterocrinus ? subglobosus, n. sp., pl. iii, fig. 5.

Calyx ovate-subglobose, asymmetrical. Sides of the dorsal cup curving regularly from the base to the arm bases, the greatest width being at about the top of the first costals. Plates ornamented with central nodes, which are joined with the central nodes of each adjacent plate by strong, rather sharp radiating ridges.

Infrabasals five, small, forming a shallow spreading cup. Basals of medium size, four of them pointed above, the posterior one truncated by the first anal plate. Radials larger than the basals, about as wide or a little wider than high, four of them heptagonal, the two posterior ones hexagonal. First costals hexagonal, a little smaller than the radials. Second costals smaller than the first. The succeeding plates, which take part in the arms, not observed. First interbranchials hexagonal, nearly as large as the radials, followed by two smaller plates in the second row, and still smaller ones above. First anal plate octagonal, the largest plate in the calyx, followed by three smaller plates in the second row and others above.

Ventral disk convex, asymmetrical, the center of radiation crowded toward the anterior ray. Posterior interradius protuberant and leading up to a vertical proboscis. The other interambulacral spaces concave in the internal cast.

Arms unknown.

Remarks: This species is only known from imperfectly preserved specimens, in which the external features are not

well seen. From the nature of the specimens it is also uncertain whether the arms are really tubular extensions of the body and therefore whether the species is really a *Lampterocrinus*. So far as preserved, however, the specimens conform to the generic characters of that genus and the species is consequently included in it provisionally.

Localities—Bridgeport and Hawthorn.

Lampterocrinus ? dubius, n. sp., pl. ii, figs. 6-7.

Calyx low. Dorsal cup about as high as wide, the sides spreading regularly from the infrabasal plates to the bases of the arms. Arm bases prominent. All the plates of the calyx strongly nodose, the basals connected with each of the adjacent plates by faint radiating ridges.

Infrabasals five, apparently anchylosed, forming a shallow spreading cup, the sutures marked by low ridges. Basals large, about as high as wide, four of them angular above, the posterior one truncated by the first anal plate. Radials about as large as the basals, wider than high. First costals very thick, much wider than high. Second costals similar to the first; in only the two posterior rays do they take part in the calyx; in the three anterior rays they are free, and with the covering plates form the bases of the tubular arms. The succeeding brachial plates, to the fourth costal, at least, similar to the first and second costals. No distichals observed. First interbrachial plates hexagonal, almost as large as the basals, followed by two somewhat smaller plates which are placed directly between the arm bases. First anal plate smaller than the regular first interbrachials, followed by one larger plate in the second row. Above the second anal plate there is a third large plate within the ventral disk, with a much smaller plate on either side.

Ventral disk known only in the internal casts. The plates are smaller than those of the dorsal cup, those of the ambulacral areas extending outward to form, with the costals, the tubular arms. The posterior interambulacral space extended into a large and long proboscis.

The arms are large tubular extensions of the calyx, consisting dorsally, so far as observed, of a single series of plates, the costals, and ventrally of covering plates which are continuous with the ambulacral plates of the vault. Lateral armlets doubtless exist, but their position and manner of divergence has not been observed.

Remarks: This species diverges widely in its characters from the typical *Lampterocrinus*, so far indeed that it perhaps represents an undescribed genus. The arms correspond with those of *Lampterocrinus* in being tubular extensions of the calyx, but they differ in having no brachial plates of higher order than the costals. The rays differ from *Lampterocrinus* in having but one costal included in the calyx, save in the two posterior rays. The interbrachial spaces have a smaller number of plates than *Lampterocrinus*, and the anal interradius differs from that genus in having a single row of anal plates with no supplementary interradials in the dorsal cup.

Localities—Lemont and Joliet.

Genus 9 **SIPHONOCRINUS** S. A. M.

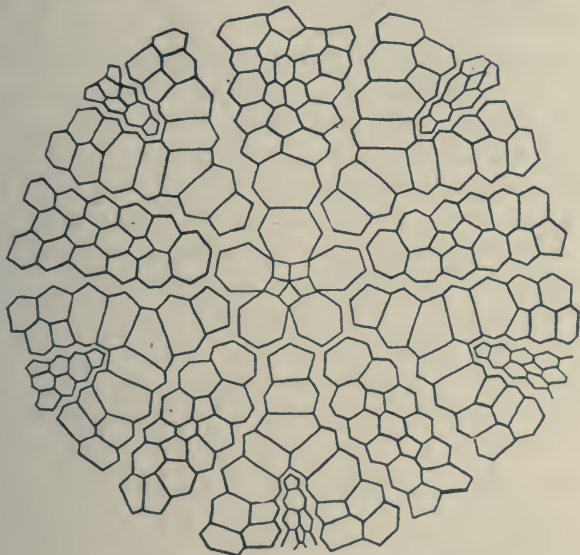


FIG. 40.—Diagram of *Siphonocrinus*.

Calyx large, oblong, its form extremely asymmetrical. Dorsal cup deeply depressed interradially, the rays projecting so as to give to the calyx a strongly lobed outline. Ventral disk generally as high as the dorsal cup, its posterior side inflated from below the brachial zone to the summit, forming a conspicuous helmet-shaped protuberance, which at the arm regions not only occupies the whole width of the posterior interradius, but encroaches largely upon the left posterior ray, not involving the ray to the right, from which it is separated by a

deep groove. The protuberance, as seen upon the casts, grows narrower at the summit, and the upper part either bends directly upward in the form of a central tube, or it continues across the summit to the anterior side, where it opens out to the exterior at or below the arm bases.

Infrabasals five. Basals elongate, variable in form, four of them angular or truncated above, the posterior one always broadly truncated and supporting the first anal plate. Radials decidedly angular below. Costals two, the first generally hexagonal. Distichals varying from two to four in different rays, there being generally two in the anterior rays against three or four in the posterior ones. The interbranchials, which are numerous and of rather large size, pass uninterruptedly from the dorsal to the ventral side of the calyx, and are in contact with the interambulacra. The first plate of the regular sides rests deeply between the sloping upper faces of two radials, its lower angle sometimes truncated and resting upon the basals, two plates in the second row, and two or three in the succeeding ones. Anal side wider and larger throughout; the first anal plate placed upon the truncated basal, supporting two or three plates in the second row, and three or more in all succeeding rows. The ventral surface of the casts is marked by well-defined ridges, converging from the arm bases to a pentangular, somewhat elevated space behind the anus, the center of which is represented by a small cone. These converging ridges are open grooves or galleries upon the inner floor of the disk for the reception of subtegmina ambulacra, and the pentangular space in front of the anal tube represents the peristome, of which the mouth occupies the median part. Anal opening placed at the distal end of a tube, which is either erect and passes outward at the summit of the disk, giving to the mouth an eccentric position, or is continued beneath the plates of the disk to the anterior side of the calyx, where it opens out interradially or interdistichally at or below the arm regions. Ventral disk covered with comparatively large plates, forming a sort of vault, in which neither orals nor covering pieces can be distinguished.

Siphonocrinus nobilis Hall, pl. ii, fig. 1.

1861. *Glyptocrinus nobilis*. Hall, Rep. Prog. Geol. Surv. Wis., p. 21.

1867. *Glyptocrinus nobilis*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., 1st Ed., p. 328, pl. x, figs. 9-10.

1870. *Glyptocrinis nobilis*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., Rev. Ed., p. 372, pl. x, figs. 9-10.

1881. (?) *Glyptocrinus nobilis*. Wachsmuth and Springer, Rev. Palæocr., pt. II, p. 189.
1882. *Glyptocrinus nobilis*. Whitfield, Geol. Wis., vol. IV, p. 282, pl. xvi, figs. 9-10.
1888. *Siphonocrinus nobilis*. Miller, Am. Geol., vol. I, p. 263.
1897. *Siphonocrinus nobilis*. Wachsmuth and Springer, N. Am. Crin. Cam., vol. I, p. 212, pl. xix, figs. 1 a-b, 2 a-c.

Calyx very large, subovoid, ventral disk as high or higher than the dorsal cup, sides of both the dorsal cup and ventral disk decidedly convex. Depressed between the arm bases.

Infrabasals small, forming a shallow cup. Basals as high as wide, pentagonal or hexagonal, reaching up between the radials and sometimes meeting the first interbranchials. Radials usually pentagonal, about as large as the basals, not always in contact laterally. First costals hexagonal, wider than high, as large as, or a little larger than, the radials; second costals pentagonal, about as large as the first. Distichals generally two in each series, about as large as the costals. The axillary distichals are each followed by two series of smaller palmars of several plates each, which lead up to the arm openings. First interbranchials generally larger than the other plates in the dorsal cup, separating the radials of adjacent rays and sometimes resting upon the truncated distal ends of the basals, followed by several rows of two smaller plates each; up to the arm bases where there is generally but one plate. Posterior interradius similar to the others, but wider and containing three plates instead of two above the first. Interdistichal spaces filled with several rows of interdistichal plates, with one or two plates in each row.

Ventral disk covered with numerous irregular plates which are small in the region of the arm bases but grow larger toward the summit. The ambulacral furrows are represented in the casts by ridges which bifurcate first well up toward the summit, and again near the margins, making four arm openings for each ray. The spaces between the rays, except the posterior one, and between the two main divisions of each ray, are depressed nearly to the summit, the arm bases standing out prominently. The posterior interradius on the vault, greatly inflated, forming an immense projection which begins in the dorsal cup and extends over one third of the whole surface of the disk, giving the specimens an exceedingly irregular form. The projection resembles an inflated sac which grows decidedly

smaller toward the upper end, and on approaching the summit turns abruptly upward in the form of a large anal tube.

Arms unknown, but judging from the bases there were four from each ray.

Remarks: This species is not uncommon in the Bridgeport beds, and is often of large size, but it has not been observed with the plates preserved. The large internal casts are often rough and unsymmetrical looking objects, and but rarely can the outlines of the plates be distinguished; it is even more uncommon to find good external impressions. The relative proportions of height to breadth vary greatly, from almost equality to forms nearly twice as high as wide.

Of the three recognized species of the genus this is the only one that has been observed as yet in our area, the other two being Wisconsin species. *S. nobilis* differs from *S. armosus* in the vertical direction of the terminal portion of the anal tube; from *S. pentagonus* it differs in having four primary arms from each ray instead of two. From both of the other species *S. nobilis* often differs in having the distal ends of all the basals truncated by the first interbranchials, so that none of the radials are in contact laterally. In those specimens where the interbranchial plates upon all sides rest upon the truncated distal faces of the basals, this species has essentially the characters of the family *Rhodocrinidæ*. We have, therefore, a curious instance here, in which the same species possesses in different individuals the characters of two families. It may be questioned, therefore, whether the families *Thysanocrinidæ* and *Rhodocrinidæ* should be considered as distinct.

Localities—Bridgeport and Joliet.

FAMILY IV. RHODOCRINIDÆ.

Genus 10 **ARCHÆOCRINUS** Wachsmuth and Springer.



FIG. 41.—Diagram of *Archæocrinus*.

Calyx medium sized or large, obconical, subovate or somewhat depressed; plates smooth or variously ornamented, those in a radial direction marked along their median line by obscure flattened ridges, which grow more conspicuous on approaching the arms. Infrabasals small, rarely extending beyond the column, and resting, as a rule, within a con-

cavity formed by the lower part of the basals. Basals heptagonal, their distal ends truncated. Radials in three of the rays pentagonal, in the two posterior ones frequently hexagonal. When there are no palmars the three to six lower distichals take part in the calyx, and the succeeding ones are free arm plates. Arms short, slender, branching; composed of two rows of cuneiform pieces, alternately arranged and interlocking. Interradial areas constructed of numerous plates, the first, which is much larger than the others, is followed on the regular sides by two interbranchials in the second row, and at the anal side by three. The upper interbranchials connect imperceptibly with the plates of the disk. Interdistichals always represented. Column round, the edges of the nodal joints largely projecting over the internodal ones; the axial canal large, pentalobate.

Remarks: Although *Archæocrinus* has hitherto been recognized only in the faunas of the Trenton limestone, the species here described agrees in all respects, so far as it is preserved, with Wachsmuth and Springer's definition of that genus. It is rather remarkable to find the genus at an horizon near the top of the Niagaran limestone, but there is no other one in which the species can be placed, and there would be no justification in creating a new genus for its reception. Miller and Gurley* have described a species from St. Paul, Ind., which is very similar to this one in general form, the only essential difference being that the Indiana specimen is said to have but three infrabasals. A new genus, *Emperocrinus*, is established for their species. It is possible that the number of infrabasals was not correctly determined in the St. Paul specimen, and that there are really five instead of three. In such a case the Chicago species here described should doubtless be referred to *Emperocrinus* if that is really a good genus. On the other hand, it is possible that Miller and Gurley's species should also be referred to *Archæocrinus*.

Archæocrinus depressus, n. sp., pl. iii, figs. 9-10.

Dorsal cup basin or bowl shaped, wider than high, excavated at the base. The radial series stand out prominently as broad rounded ridges, the interradian areas depressed.

Infrabasals small, entirely included in the basal depression and apparently covered by the column. Basals higher than wide, the proximal ends bent inward to form the sides of the

* Bull. No. 6, Ill. State Mus. Nat. Hist., p. 43 (1895).

basal concavity, the distal portion bent outward and upward to form a part of the sides of the calyx, the distal ends truncated by the first interbranchials. Radials pentagonal, wider than high. First costals quadrangular except in the posterior rays where they are pentagonal, much wider than high; second costals pentagonal, wider than high, about equal in size to the first. The two first distichals in each ray in contact with each other, hexagonal, wider than high, nearly as large as the costals; second and third distichals in each series successively smaller than the first; the succeeding plates not preserved. First interbranchial plates in the regular interradian areas, the largest plates in the calyx, reaching up to the middle of the first distichals, eleven-sided, subcircular in outline, followed by two plates in the second row, the succeeding plates not preserved. In the posterior interradius the first plate is octagonal, reaching up to the middle of the first costals, followed by three plates in the second row and three in the third, the median series being slightly elevated in a rounded ridge. One interdistichal in each ray, lying in the notch formed by the upper lateral faces of the first distichals and between the second and third distichals.

Arms and ventral disk not known.

Remarks: This species is not a common one in the collections from the Chicago area.

Localities—Bridgeport, Cicero, and Hawthorn.

Genus 11 LYRIOCRINUS Hall.

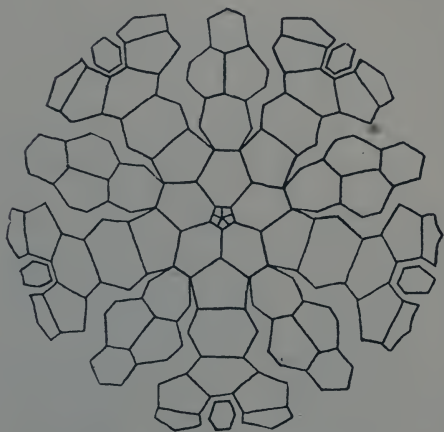


FIG. 42.—Diagram of *Lyriocrinus*.

Calyx depressed-globose, more or less flattened to the middle of the radials; symmetry almost perfectly pentamerous; plates heavy, their surfaces smooth or finely granular; ventral disk not rising above the dorsal cup; arm openings directed upward, placed at the margin of the disk. Infrabasals five, very small, abruptly and

deeply depressed and concealed by the column. Basals five, of uniform size, either all heptagonal and supporting the first interdistichal plates upon the distal truncated face, or quite frequently one or more of them hexagonal, and angular at the top. Costals two, large. Two of the distichals included in the calyx. Arms two to each ray, rising in a straight line with the sides of the calyx, simple, strong, biserial, two of the interlocking plates frequently in the calyx. Interbranchials four, in three rows of one, two, and one. Anal side generally not distinct, but exceptionally it has a special anal plate in the second row. Disk flat, somewhat depressed in the interradian regions, composed of a large number of slightly convex, delicate plates, and well-defined orals. Anus subcentral, probably at the end of a small tube.

Lyriocrinus melissa Hall, pl. iii, figs. 6-8.

- 1863. *Rhodocrinus Melissa*. Hall, Trans. Albany Inst., vol. IV, p. 198.
- 1879. *Rhodocrinus (Lyriocrinus) Melissa*. Hall, 28th Rep. N. Y. State Cab. Nat. Hist., p. 139, pl. xv, figs. 18-27.
- 1881. *Lyriocrinus melissa*. Wachsmuth and Springer, Rev. Palæocr., pt. II, p. 205.
- 1882. *Lyriocrinus Melissa*. Hall, 11th Rep. Dep. Geol. and Nat. Hist. Ind., p. 269, pl. xiv, figs. 18-27, pl. xv, fig. 11.
- 1897. *Lyriocrinus melissa*. Wachsmuth and Springer, N. Am. Crin. Cam., vol. I, p. 263, pl. xi, figs. 4a-f.

Calyx depressed, nearly twice as wide as high, distinctly flattened to the distal ends of the radials, then curving rapidly upward until the sides of the upper part are at right angles to the flattened part below, then somewhat constricted below the arm bases. Base excavated, the cavity being but slightly wider than the diameter of the column. Surface of the plates flat, smooth, or finely corrugated.

Infrabasals small, concealed by the column. Basals elongate, truncated at the distal end, the proximal end bent inward to form the sides of the basal concavity, the distal portion nearly horizontal. Radials large, pentagonal, wider than high. First costals hexagonal, wider than high, about equal to the radials in size; second costals hexagonal, about the size of the first, supporting on its two upper sloping sides the distichals and upon its distal truncation an interdistichal plate. Distichals two in each series; the first large, pentagonal, the second smaller. First interbranchials as large as the radials, heptagonal, resting upon the truncated distal end of the basals, followed by two hexagonal plates in the second row which are

nearly as large as the first, and one smaller plate in the third row. The posterior interradius is not distinguishable from the others in the dorsal cup. A single interdistichal is present, which rests upon the truncated distal end of the second costal.

Arms and ventral disk not preserved.

Remarks: This species is not uncommon in the collections from Bridgeport, but is generally in the form of internal casts. One specimen with a very small portion of the plates has been observed, and it preserves the delicate sculpturing seen upon specimens from Waldron, Ind. The species may be easily recognized by its almost uniform sized plates and by the perfectly pentamerous symmetry in the arrangement of the plates of the dorsal cup.

Localities—Bridgeport, Romeo, and Joliet.

Family V. MELOCRINIDÆ.

Genus 12 **MACROSTYLOCRINUS** Hall.

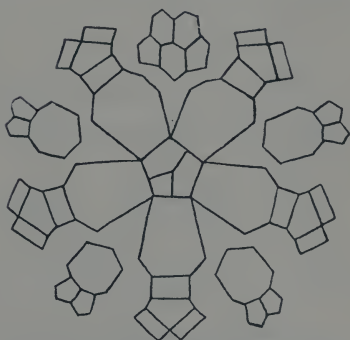


FIG. 43.—Diagram of *Macrostylocrinus*.

Calyx obconical to subglobose, generally with prominent ridges along the rays and the anal plates; the surface usually ornamented with very fine striæ or small granules.

Basals three, large, unequal, forming a spreading cup of greater or less depth, two of the plates equal, the other one-half smaller. Radials very large, their upper corners but slightly truncated by the interbranchials. Costals two, small, rarely more than one third the size of the radials, and in some species still smaller. Generally only the first one of the distichals is included in the calyx, but occasionally also the second:

Arms ten, long, biserial and simple throughout. Interbranchials few. Anal area much the widest and quite distinct; it has three plates in the first row, of which the middle one is placed against the sloping upper faces of the two posterior radials, while the two smaller ones at the sides, together with the first costal, occupy the upper face of the plate. The middle or anal plate is generally followed by one or two other anals

longitudinally arranged. Ventral disk low, composed, so far as observed, of small, irregular pieces. Column round, axial canal small.

Macrostylocrinus striatus Hall, pl. iv, figs. 10-11.

- 1863. *Macrostylocrinus striatus*. Hall, Trans. Albany Inst., vol. IV, p. 207.
- 1879. *Macrostylocrinus striatus*. Hall, 28th Rep. N. Y. State Mus. Nat. Hist., p. 129, pl. xiii, figs. 1-4.
- 1881. *Macrostylocrinus striatus*. Wachsmuth and Springer, Rev. Palæocr., pt. II, p. 103.
- 1882. *Macrostylocrinus striatus*. Hall, 11th Ann. Rep. Dep. Geol. and Nat. Hist. Ind., p. 257, pl. xii, figs. 1-4.
- 1897. *Macrostylocrinus striatus*. Wachsmuth and Springer, N. Am. Crin. Cam., vol. I, p. 287, pl. xxii, figs. 14a-c.

Calyx pentangular, obpyramidal; the rays forming five rounded ridges, the interbrachial spaces flattened or concave except at the posterior side where the median portion is slightly protuberant; deeply depressed between the arm bases. Surface of the plates ornamented with fine radiating striæ.

Basals three, unequal, rather large, forming a basin-shaped cup whose upper margin is distinctly pentangular. Radials very large, higher than wide, the lower lateral faces being much the longest, divided longitudinally by a rounded ridge, the portion of the plate on each side of the median ridge on a plane with the adjoining half of the adjacent radials. First costals less than one fourth the size of the radials, convex transversely, quadrangular, pentagonal, or hexagonal, dependent upon the size of the adjacent first interbrachials; second costals pentagonal, about equal in size to the first. First palmars quadrangular, smaller than the costals. First interbrachials hexagonal, as large or larger than the costals, followed by two smaller plates in the second row and two more in the third. Posterior interradius wider than the others, with three plates in the first row, the middle one being convex and somewhat protuberant, the following plates not observed.

Arms and ventral disk not preserved.

Remarks: This is not a common species in the collections from Bridgeport, where it is generally preserved as internal casts, only one specimen with the plates having been seen. The Chicago specimens differ from the species as it has been illustrated from Indiana, in their proportionally narrower or more slender form, but this does not seem to be an essential

specific difference. The Chicago specimens are preserved in such a manner that the fine surface markings are not as perfect as in those from the Waldron shale, but the same style of ornamentation is unquestionably present. The internal casts differ from the external form in the rounder pointed base, otherwise the general proportions are closely similar to the exterior. The surface ornamentation is of course lacking in the internal casts.

The specimens from Racine, Wis., which were referred to this species by Hall,* are evidently representatives of some other species, possibly an undescribed one.

Locality—Bridgeport.

Macrostylocrinus semiradiatus (Hall), pl. iv, fig. 9.

- 1867. *Actinocrinus* (*Saccocrinus*) *semiradiatus*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., 1st Ed., p. 379, pl. x (1), fig. 1.
- 1870. *Actinocrinus* (*Saccocrinus*) *semiradiatus*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., Rev. Ed., p. 370, pl. x, fig. 1.
- 1881. (?) *Periechocrinus semiradiatus*. Wachsmuth and Springer, Rev. Palæocr., pt. II, p. 133.

Calyx higher than wide, obtusely rounded at the base, subcylindrical above.

Basals large, forming a rounded cup. Radials unusually large, higher than wide, the two lower lateral faces much the longest. First costals less than one fourth the size of the radials, quadrangular, wider than high; second costals not preserved. In the internal cast, near the top of the median longitudinal line on each radial, a small elongate node, with subparallel sides and rounded ends, takes its origin and passes across the suture between the radial and first costal to near the middle point of the costal. At the middle of the first costal this node is discontinuous, but is followed just above the middle by another similar node which crosses the suture between the first and second costals. First interbranchials hexagonal, larger than the first costals, and apparently followed by two plates in the second row. The succeeding plates of the calyx not preserved.

Remarks: This species is rare in the collections from Bridgeport, but one specimen, and that an imperfect internal cast, having been observed. It differs from the associated species in its larger size and in the more nearly cylindrical calyx above the basals.

* Twentieth Rep. N. Y. State Cab. Nat. Hist., p. 327 (Rev. Ed., p. 371), pl. x, figs. 7-8.

The specimen from Bridgeport differs from the one figured by Hall in its quadrangular first costal plates, they being hexagonal in Hall's figure. Other species of the genus are known to vary in this same character, the form of the first costal plate being dependent upon the varying size of the first interbrachial; when the top of that plate reaches above the top of the first costal the latter plate is quadrangular, but when it does not reach to the top it is hexagonal in form.

In general form *M. semiradiatus* agrees closely with *M. fasciatus*, Hall,* and in N. Am. Crin. Cam., p. 289, Wachsmuth and Springer suggest the identity of the two species. Until the external characters of *M. semiradiatus* can be seen it will be impossible to establish the identity of the two species, but if they are found to be the same the name *semiradiatus* will have to be retained, it having several years priority.

Locality—Bridgeport.

Macrostylocrinus obconicus, n. sp., pl. iv, figs. 6-7.

Calyx obconical, truncated below, higher than wide, cross section subcircular below, but becoming pentangular toward the arm bases where the rays become more prominent as broadly rounded ridges. The interbrachial spaces flattened, but not concave except between the arm bases. Surface of the plates smooth.

Basals three, unequal, rather large, forming a basin-shaped cup. Radials large, three of them heptagonal the other two hexagonal, higher than wide, obscurely angular along the median line, especially toward the distal end. First costals nearly half as large as the radials, hexagonal, about as high as they are wide, with a broadly rounded median ridge; second costals pentagonal, protuberant, smaller than the first. Succeeding plates of the rays not preserved. First interbrachials hexagonal, about as large as the first costals, followed by two much smaller plates in the second row and three still smaller ones in the third, which join with the interambulacral plates of the ventral disk. Anal plate a little larger than the regular first

* See 1876. *Cyathocrinus fasciatus*. Hall, 28th Rep. N. Y. State Mus. Nat. Hist., Doc. Ed., pl. xiii, figs. 5-6.

1879. *Macrostylocrinus fasciatus*. Hall, 28th Rep. N. Y. State Mus. Nat. Hist., Mus. Ed., p. 130, pl. xiii, figs. 5-6.

1882. *Macrostylocrinus fasciatus*. Hall, 11th Rep. Dep. Geol. and Nat. Hist. Ind., p. 258, pl. xii, figs. 5-6.

1897. *Macrostylocrinus fasciatus*. Wachsmuth and Springer, N. Am. Crin. Cam., Vol. I, p. 288, pl. xxii, fig. 13.

interbrachials, followed by three plates in the second row. The succeeding plates not observed.

Remarks: This species is not uncommon from Bridgeport, but is generally found in the form of internal casts. These casts are quite constant in their characters, as shown in the illustration, they having a much rougher appearance than the exterior. The species is more closely allied to *M. semiradiatus* than to any of the other associated species, but may be easily distinguished from it by its narrower base and its more slender form.

Locality—Bridgeport.

Macrostylocrinus subglobosus, n. sp., pl. iv, fig. 8.

Calyx subglobose, not much higher than wide, cross section circular. Surface ornamentation of the plates unknown, as the species has been observed only in the form of internal casts.

Basals three, of medium size, unequal, forming a shallow, saucer-shaped cup. Radials large, wider than high. First costals very small and short, quadrangular, three times as wide as high; second costals pentagonal, much larger than the first. First distichals nearly as large as the second costals, the succeeding plates incorporated in the arms. First interbrachials very large, reaching to the tops of the first distichals and practically filling the whole of the interbrachial spaces in the dorsal cup.

Ventral disk depressed hemispherical, its lower margin projecting slightly beyond the upper margin of the dorsal cup. In the casts the ambulacral grooves are represented by elevated ridges which radiate from the center, bifurcating about midway between the center and the margin, with that portion of the disk between the branches elevated to near the margin, where it is sharply depressed between the bases of the arms. The arm bases overhanging the dorsal cup. The posterior interambulacral space occupied by a protuberance which represents the anal opening.

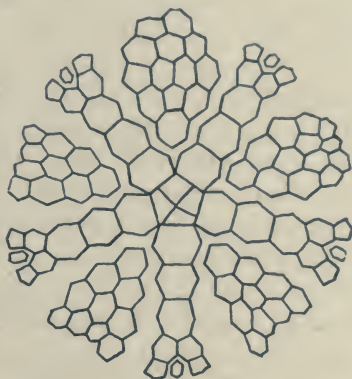
Remarks: This species is very distinct from any other one of the genus, and may be easily recognized from the internal casts by its subglobular form, its very large interbrachial plates and the overhanging arm bases.

Locality—Bridgeport.

Genus 13 **MELOCRINUS** Goldfuss.

Calyx obconical, subglobose or pyriform, plates variously ornamented; the rays extended into free tubular appendages bearing arms on both sides.

Basals four, three of them quadrangular, the anterior one larger and pentangular. Radials in contact laterally, four of them heptagonal, the anterior one hexagonal. Costals two, the first hexagonal, the second pentagonal or heptagonal; the sloping faces of the latter equal and supporting two rows of distichals, or unequal, when only the longer side supports a series of distichals, the shorter side giving support to the proximal arm. Interbrachials numerous, the first one supported by the upper sloping faces of the radials, followed by two plates in the second row in the four regular sides, and by three in the posterior interradius, and these followed by a greater or less number of irregular plates. Ventral disk nearly flat or highly elevated. Anus eccentric and sometimes, perhaps always, extended into a small tube.

FIG. 44.—Diagram of *Melocrinus*.

Melocrinus obpyramidalis (Winchell and Marcy), pl. iii, figs. 11-12.

1865. *Actinocrinus obpyramidalis*. Winchell and Marcy, Mem. Bost. Soc. Nat. Hist., vol. I, p. 87, pl. ii, fig. 4.

1867. *Melocrinus verneuili*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., 1st Ed., p. 327, pl. x, fig. 5.

1870. *Melocrinus verneuili*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., Rev. Ed., p. 372, pl. x, fig. 5.

1881. *Melocrinus obpyramidalis*. S. A. M., Jour. Cinn. Soc. Nat. Hist., vol. IV, p. 174.

1881. *Melocrinus obpyramidalis*. Wachsmuth and Springer, Rev. Palæocr., pt. II, p. 122.

Dorsal cup pentangular obpyramidal, truncated at the base for the attachment of the column. The brachial series stand out in salient angles; the interbrachial spaces depressed, deepening upward and giving great prominence to the arm bases. Plates nodose, the central node of each plate connected with the central nodes of the adjacent plates by prominent ridges; the ridges along the brachial series more prominent than the others.

Basals four, about as wide as high. Radials a little higher than wide, hexagonal and heptagonal. First costals hexagonal, a little higher than wide, not quite as large as the radials; second costals heptagonal, as large as or a little smaller than the first, higher than wide. Two distichals in each series, the first hexagonal, smaller than the costals; the second pentagonal, smaller than the first. Palmars present, but their number and form indistinguishable. First interbranchials hexagonal, about as large as the first costals, followed by two slightly smaller hexagonal plates in the second row and three still smaller ones in the third; the succeeding plates not entirely distinguishable. A single interdistichal in each ray. The plates of the posterior interradius not determined.

Ventral disk nearly flat, covered with small plates, and possessing a subcentral anal opening with perhaps a very short proboscis.

Arms unknown.

Remarks: The distinction between the two genera, *Melocrinus* and *Mariacrinus*, is in the character of the arms. In the former genus the arms are essentially tubular extensions of the calyx, giving off lateral, biserial, pinnule-bearing arms, while in the latter the arms are of the normal type. In no case have the Chicago specimens preserved the arms with sufficient perfection to allow of certain generic determination of *M. obpyramidalis*. In the internal casts from this locality, when sufficiently well preserved, the fractured terminations of the rays seem to indicate the presence of two large arm openings, which would suggest that they belonged to *Melocrinus* rather than *Mariacrinus*, in which genus there should be four small openings to each ray. It is possible, however, that the rays may have usually been broken off low down in such a manner as to leave two large openings, which would not represent the true arm openings.

In general form and ornamentation *M. obpyramidalis* agrees more closely with *Mariacrinus carleyi* from Waldron, Ind., than with any species of *Melocrinus*, and because of this resemblance some hesitation has been felt in placing the species in a different genus. However, since the species has always been considered as a *Melocrinus*, and as no characters are preserved disproving its alliance to this genus, it has been thought best to retain it provisionally in the genus *Melocrinus*. The only species of *Melocrinus* with which *M. obpyramidalis* need be com-

pared is *M. obconicus*, from Waldron, Ind., but the ornamentation of the plates in *M. obpyramidalis* is in the form of much more definite radiating ridges, and the interbrachial areas are flatter.

The species is not an uncommon one in the condition of internal casts in the Bridgeport beds, but specimens preserving the plates, or good natural moulds of the exterior, are rare. The illustration of the external characters of the species is drawn from a wax cast of the best natural mould observed.

Localities—Bridgeport, Hawthorn, Romeo, and Joliet.

Genus 14 **CORYMBOCRINUS** Angelin.

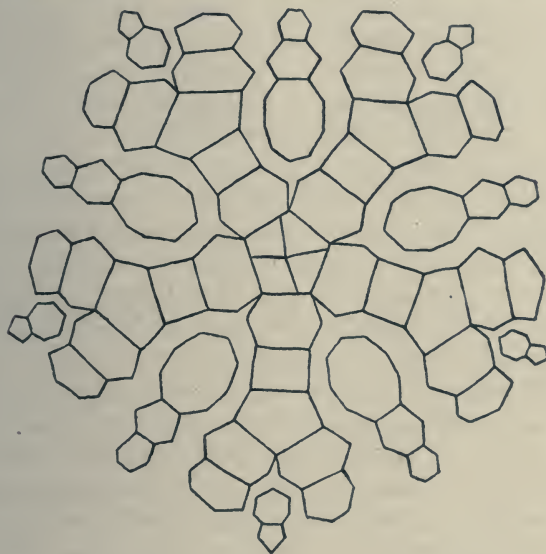


FIG. 45.—Diagram of *Corymbocrinus*.

Calyx basin or cup shaped; basal portions broadly and deeply excavated; plates rather heavy, somewhat convex, rarely ornamented; symmetry regularly pentamerous, except in the basals.

Basals four, unequal, the distal portions abruptly recurved at the margin of the columnar facet to form the inner portion of the subcylindrical basal excavation. Radials large, the proximal portion forming the major part of the walls of the basal excavation, the distal portion bent at right angles to the column. First costals quadrangular, wider than high, frequently with convex lower edges, narrower than the radials.

Second costals pentagonal, axillary. Distichals two in each series, rather large. Two vertical series of palmars follow each distichal, arranged alternately like the double series of arm plates, but connected by interbrachial and interdistichal plates and hence forming parts of the calyx.

Arms long, bifurcating, gradually tapering to the distal ends, from their base up composed of a double series of short but wide interlocking pieces. Pinnules long.

Interbrachials arranged in one longitudinal series; the first plate the largest in the calyx, nine-sided, extending from the upper sloping sides of the radials to the first distichals; the second plate is smaller, hexagonal, higher than wide, and placed between the distichals of adjacent rays. There are two more interbrachial pieces above, which are longitudinally arranged. Interdistichal plates one or two, the upper one cuneate and inserted between the palmars. This arrangement of plates is uniform in all five radial and interradian areas.

Construction of the ventral disk unknown. Column large, round, composed of low segments; axial canal pentalobate.

Remarks: The genus *Corymbocrinus* has not been previously recognized in America. In Wachsmuth and Springer's Revision of the Palæocrinoidea, Part III, page 108, six species of the genus are recorded, all of them from the Silurian beds of Gotland, Sweden, and one from England.

The species of *Corymbocrinus* when poorly preserved may be confused with *Eucalyptocrinus* of the type of *E. depressus*; the arrangement of the plates in the dorsal cup, so far as it is usually preserved, is identical in the two genera, except for the presence in *Corymbocrinus* of a single interbrachial plate in the second row instead of two, as in *Eucalyptocrinus*. If the arms could be observed (see Fig. 31, p. 42) there would be no confusion between the two genera, and although the vault of *Corymbocrinus* has not yet been observed, it is certainly not similar to the highly differentiated vault of *Eucalyptocrinus*.

***Corymbocrinus Chicagoensis*, n. sp., pl. iv, figs. 1-3.**

Calyx about as high as wide, basin-shaped, sides nearly vertical above the first costals. Base deeply excavated. Plates heavy, convex.

Basal plates four, placed at the bottom of a remarkably deep and wide subcylindrical excavation, the bottom of which is about on a level with the tops of the second costals. Radials large, a large portion of them included in the basal exca-

vation, their distal ends bent abruptly outward in a nearly horizontal position. First costals quadrangular, wider than high; second costals pentagonal, wider than high, as large as or a little larger than the first. First distichals equaling in size, or larger than the costals; second distichals much smaller than the first, followed by two palmars. First interbrachials twice the size of the costals, nine-sided, subcircular in outline; second interbrachials higher than wide, extending to the middle of the second distichals, followed by two more smaller plates in longitudinal series. Interdistichals two, the second one much smaller than the first.

Ventral disk and arms unknown.

Remarks: This species differs from *C. niagarensis* in its more nearly vertical sides, in its more convex plates, and in its more nearly cylindrical basal excavation. The sides of the basal cavity in this species are subparallel, the diameter at the outside being but slightly greater than that at the bottom; the diameter of the column is equal to the diameter of the bottom of the excavation, and the sides of the cavity through its whole depth must have been almost in contact with the column.

The internal casts of the dorsal cup of *Corymbocrinus* are not uncommon in the collections from Bridgeport. The casts are characterized by the remarkably broad and deep basal cavity. The outlines of the plates are but rarely distinguishable, and from the casts alone it is not practicable to distinguish the two species of the genus which have been recognized.

Localities—Chicago, Cicero, and Romeo.

Corymbocrinus niagarensis, n. sp., pl. iv, figs. 4-5.

Calyx depressed, basin shaped, sides convex. Base deeply excavated, the bottom of the cavity being on a level with the second costals. Plates rather thick, slightly convex, depressed along the sutures, especially at the angles where the adjacent sutures meet the bounding suture of the first interbrachial plate.

Basal plates four, unequal, placed at the bottom of the deep excavation; the distal ends bent abruptly downward parallel to the sides of the column, forming the lower part of the sides as well as the bottom of the hollow, conical excavation. Radials large, a large portion of them forming the sides of the basal excavation, their distal ends bent abruptly outward in a nearly horizontal position. First costals quadrangular, wider than high; second costals pentagonal, wider than high, as large as or a little larger than the first. First distichals equal to or larger

than the costals; the following plates not present in the type specimen. First interbrachial as large as the two costals combined, nine-sided, subcircular in outline; second interbrachial lying between the first distichals of adjacent rays, much narrower than the first, its full height not recognizable.

The ventral disk and arms unknown.

Remarks: This species differs from *C. chicagoensis* in its more flaring sides and in its less convex plates, which are depressed along the sutures near the angles at which the adjacent sutures meet the bounding suture of the first interbrachial. The sides of the basal excavation in this species are less nearly parallel than in *C. chicagoensis*, its diameter at the outer margin being nearly twice that at the bottom of the depression, where it is just equal to the diameter of the column.

Although internal casts of *Corymbocrinus* are not uncommon in the Bridgeport collections, but two specimens have been seen which preserve the plates, and these two specimens have been made the types of the two species of the genus which are here recognized. Were the fully preserved specimens more common, it is possible that the two species, *C. chicagoensis* and *C. niagarensis*, would be found to be but extreme variations of a single species, in which case the name *C. chicagoensis* should be retained for all of them, unless they should all be referred to the European species *C. polydactylus*, an illustration of which may be seen on page 42 of this bulletin.

Locality—Chicago.

Family VI. CALYPTOCRINIDÆ.

Genus 15 EUCALYPTOCRINUS Goldfuss.



FIG. 46. — Diagram of *Eucalyptocrinus*.

Calyx with the arms attached, more or less ovate; without the arms, resembling a wine bottle with concave bottom and slender neck, the neck surrounded by ten longitudinal partitions closed from above, and forming ten niches or compartments into which the arms, in pairs, and to their full length, exactly fit. Dorsal cup composed of four bas-

als, five radials; two costals in each ray, two distichals in each series, one palmar in each series, three interbranchials in each area, and one interdistichal in each ray.

The basals, which form an inverted, funnel-shaped cup, are not visible from a side view, and the calyx rests upon the edges of the inflected proximal portions of the radials; the plates varying in size, the anterior one larger than the rest and pierced by two rays of the pentalobate axial canal. Radials large, hexagonal, the proximal ends forming the sides of the basal concavity. First costals quadrangular, the second pentagonal, unless the upper angle is truncated by the interdistichals. First distichals pentagonal, larger than the second, which are also pentagonal. First palmars short, supporting the arms. First interbranchials generally the largest plates of the dorsal cup, more than twice as large as the two combined in the second row; the two latter are of about the same form and size, much higher than wide, and in contact laterally to their full length; they rise some distance beyond the top of the palmars in square or tapering, truncated projections, and jointly form a support for the interradian partitions. The interdistichals rest either within notches formed by the distichals, or upon the truncated upper face of the second costals; they resemble in form the combined upper interbranchials, rise like them to the height of the third arm plates, and support in a similar manner a partition wall upon their truncated upper faces.

The ventral disk consists of four rings of plates of peculiar structure. The lower ring is composed of five elongate interradian pieces, which rest upon the projecting upper faces of the interbranchials, and five plates of similar form and size supported by the interdistichals. The median portions of the ten plates extend outward and upward in the form of knife-like, winged processes, of which the upper end rises to near the fourth row of plates, overlapping the plates of the second and third rows, to the outer faces of which they are united by suture. Interposed between these plates are ten small trigonal pieces, arranged in such a manner that a plate supported by an interbranchial, and one supported by an interdistichal, always meet laterally over the top of one of the triangular pieces. The latter plates, which are somewhat thickened at their median lines, form sort of subpartitions between the arms of the various pairs, without being visible when the arms are intact. Their edges at both sides, and also those of the larger plates, are

pierced by the ambulacral or arm openings, which are well defined in this genus, and enter the calyx between the two plates. The second and third rings of plates, which form the tubular prolongation of the calyx, are composed of four plates each; the fourth ring consists of ten pieces, which meet around the summit. The plates of the second ring slope upward, two of them are wider and alternate with the other two; the two narrower plates are longer and angular at the top, and the shorter ones are truncated. United they form an inverted funnel, whose margin is surrounded by ten protuberances which represent ten longitudinal ridges upon the outer surface. The ridges meet and are joined by suture to the upward prolongations of the plates of the first ring, forming the partition walls, while the alternate grooves form the inner parts of the niches. The plates of the third ring are narrower than those of the second, and, like them, are provided with ten longitudinal elevations, which are overlapped by certain projections passing downward from the plates of the fourth ring. The plates of the upper ring are quite remarkable as forming the upper part of the anal tube, the top of the crown, and at the same time the encasement of the tips of the arms. They are constructed upon a plan similar to that of the large plates of the first ring, and, like them, have wing-like extensions which from a ventral aspect present a well-defined decagonal star, with a vacant space at the summit. The lower ends of these wings meet the upper ends of the wings of the first ring, and with them form, together with the projecting surfaces upon the plates of the two middle rings, ten continuous partition walls which extend from the edge of the dorsal cup to the top of the crown. The open space at the summit between the ends of the top ring of plates is the end of the anal canal, which is variously closed by from five to ten small, irregular pieces surrounding the anal opening, and sometimes by five additional larger plates. In some species the anus is drawn out into a tube of greater or less length extending beyond the limits of the arms, but more frequently it rises but little above the top of the compartments.

The arms are heavy, arranged in pairs, each pair occupying one of the ten compartments with their backs almost even with the edges of the partitions, and their lateral faces abutting against the sides. They have a wide ventral furrow and are composed, from the third or fourth plate up, of two rows of short, transverse pieces which are so closely united by sutures

that the arms must have moved *en masse* upon the calyx. Pinules long and closely folded.

The visceral cavity is formed by the plates of the dorsal cup and the two lower rings of the plates of the disk, the plates of the two upper rings which form the neck-like prolongation being, properly speaking, plates of the anal tube. The ambulacra, on entering the calyx, follow the grooves on the inner floor and meet near the top of the second ring.

Column moderately large, generally round, composed of rather long joints with pentalobate axial canal. It has no lateral cirri, but at the end branches into a multitude of rootlets.

Eucalyptocrinus crassus Hall, pl. v, figs. 1-2.

- 1863. *Eucalyptocrinus crassus*. Hall, Trans. Albany Inst., vol. IV, p. 197.
- 1865. *Eucalyptocrinus chicaoensis*. Winchell and Marcy, Mem. Bost. Soc. Nat. Hist., vol. I, p. 90.
- 1875. *Eucalyptocrinus* (sp. undet.). Worthen, Geol. Surv. Ill., vol. VI, pl. xxiv, figs. 2-2a.
- 1875. *Eucalyptocrinus crassus*. Hall and Whitfield, Pal. Ohio, vol. II, p. 129, pl. vi, fig. 11.
- 1879. *Eucalyptocrinus crassus*. Hall, 28th Rep. N. Y. State Mus. Nat. Hist., p. 141, pl. xvii, figs. 1-11; pl. xviii, figs. 1-9; pl. xix, figs. 2, 4, 5.
- 1879. *Eucalyptocrinus constrictus*. Hall, Trans. Albany Inst., vol. X, p. 10 (abstract).
- 1881. *Eucalyptocrinus crassus*. Hall, 11th Rep. Geol. and Nat. Hist. Ind., p. 272, pl. xvii, figs. 1-11; pl. xviii, figs. 1-9; pl. xix, figs. 2, 4, 5.
- 1881. *Eucalyptocrinus constrictus*. Hall, 11th Rep. Geol. and Nat. Hist., Ind., p. 273, pl. xv, fig. 1.
- 1885. *Eucalyptocrinus crassus*. Wachsmuth and Springer, Rev. Palæocr., pt. III, p. 133.
- 1897. *Eucalyptocrinus crassus*. Wachsmuth and Springer, N. Am. Crin. Cam., vol. I, p. 342, pl. lxxxi, figs. 1-6, 14-15.

Body large, sometimes attaining a length of 10 c. m. from the base to the top of the vault, and a width of 6 c. m., elongate subelliptical in outline, the length as a rule twice the width.

Dorsal cup subtruncate, massive, truncate and deeply excavated at the base, the sides straight, a little concave or a little convex. The height to the top of the interbranchials and interdistichals almost equal to the height of the compartments upon the ventral disk for the reception of the arms. Surface of the plates flat and without ornamentation.

Basals small, at the bottom of a deep funnel-shaped concavity. Radials large, longer than wide, forming a broad,

slightly spreading cup which extends out laterally beyond the sides of the column. First costals quadrangular, their length equal to or less than their breadth, widest at the base, the lower and lateral faces convex. Second costals smaller, equal to or larger than the first, generally pentangular, sometimes with the distal angle truncated by the interdistichal. First distichals almost as large as the axillary costals; the second, one third the size of the first. First palmars very short and trigonal. First interbranchials large, the proportion of their length to their width as five to three, the greatest width at the intercostal suture line from which point it tapers to both ends, all sides generally concave. The two plates of the second row of interbranchials truncating the distal margin of the first, and both together about two thirds its size. The interdistichal is of a similar form to the two upper interbranchials, but one third smaller.

Height of the ventral disk in the casts, without the tubular prolongation, considerably less than, and the width nearly equal to, that of the dorsal cup. The sides nearly vertical below, bending abruptly inward above and sloping rapidly to the base of the tubular prolongation. Ten conspicuous keel-like ridges extend from the interbranchial and interdistichal spaces over the vault from the base to the summit.

Arms stout, a little tapering at the upper ends. They are composed of extremely short transverse pieces.

Remarks: This is one of the commonest crinoids in the fauna, but only rarely are the specimens preserved otherwise than as internal casts. A few specimens with the plates partially preserved have been examined, and in these the plates are seen to be perfectly smooth as in the specimens from Waldron, Ind. The species exhibits a great variation in form, but not so great as the same species in the Waldron fauna. It varies in the relative height and width of the dorsal cup; in the contour of the dorsal cup, the sides of which are either somewhat constricted, straight, or bulging between the base of the cup and the arm bases, and in the amount of truncation and of excavation of the base. But rarely are the arms and the partition walls of the ventral side, or their casts, preserved, but when they can be recognized they are not unlike the same parts in the Waldron specimens. The type specimen of *E. chicagoensis*, W. and M., has been examined, and it in no respect differs from the *E. crassus*. The specimen illustrated as *E.*

crassus by Hall in the 20th Report of the N. Y. State Cabinet of Natural History is believed to be the internal cast of another species described here under the name *E. nodulosus*.

Locality—Bridgeport.

Eucalyptocrinus turbinatus S. A. M., pl. vi, figs. 1-2.

1882. *Eucalyptocrinus turbinatus*. S. A. M., Jour. Cinn. Soc. Nat. Hist., vol. V, p. 82, pl. iii, figs. 5-5a.

1885. *Eucalyptocrinus turbinatus*. Wachsmuth and Springer, Rev. Palaeocr., pt. III, p. 134.

1897. *Eucalyptocrinus turbinatus*. Wachsmuth and Springer, N. Am. Crin. Cam., vol. I, p. 351, pl. lxxxii, fig. 13.

Body rather large, depressed, in the cast nearly as high as wide.

Dorsal cup obconical, rapidly expanding upward from the basal concavity, slightly constricted above the radials, the extreme upper end curving abruptly upward. Basal concavity moderately deep and obscurely pentangular. Suture lines in the casts defined by angularities, the inner spaces of the plates slightly concave.

Radials, as exposed in a side view, comparatively small, wider than long. First costals quadrangular, nearly as long as wide; second costals hexagonal, a little larger than the first, the sloping upper sides steep, the distal ends truncated by the interdistichals. First distichals as large as the second costals; the second much smaller. Palmars minute. First interbrachial longer than wide; the two plates in the second row forming a rhomb with the two acute angles truncated. Interdistichals comparatively short.

The ventral disk, in the cast, depressed, the sides nearly vertical below, bending abruptly inward above, making the top nearly flat and meeting the tubular prolongation at nearly a right angle. The surface marked by ten well marked, keel-like, longitudinal ridges, which pass from the interbrachial and interdistichal spaces to the base of the tubular prolongation. Length of the tubular prolongation unknown.

Remarks: This rather uncommon species is known only from internal casts, and has all the appearances of being a much depressed variety of *E. crassus*. Although *E. crassus*, in its typical locality, Waldron, Ind., exhibits a remarkable range of variation, so far as known it does not assume the much depressed turbinate form of *E. turbinatus*, and as intermediate forms do not entirely connect the typical *E. turbinatus* with the typical

form of *E. crassus* in the Chicago fauna, they will, for the present at least, until more perfectly preserved material showing the external characters can be examined, be considered as two distinct species.

Locality—Bridgeport.

Eucalyptocrinus egani S. A. M., pl. vii, fig. 4.

1880. *Eucalyptocrinus* (*Hypanthocrinus*) *egani*. S. A. M., Jour. Cinn. Soc. Nat. Hist., vol. III, p. 140, pl. iv, figs. 1a-c.

1885. *Eucalyptocrinus Egani*. Wachsmuth and Springer, Rev. Palæocr., pt. III, p. 133.

1897. *Eucalyptocrinus Egani*. Wachsmuth and Springer, N. Am. Crin. Cam., vol. I, p. 352, pl. lxxxii, figs. 11-12.

Body with the partition walls between the arms attached, elongate, cylindrico-elliptical. The entire height from the base to the summit of the anal tube from two and one half to three times the width at the arm bases.

Dorsal cup a little higher than wide, obconical, the base distinctly truncated and not excavated in the casts, the sides straight or slightly convex, and projecting conspicuously over the sides of the disk. Radials nearly as long as wide. The first costals longer than wide and narrower above than below; the second about equal in length to the first, and truncated by the interdistichals. First distichals pentagonal, smaller than the costals; the second much smaller than the first, pentagonal, supporting the arms. First interbranchials the largest plates in the calyx, nearly twice as long as wide, widest at or a little above the middle. The two interbranchials in the second row together much smaller than the first. The interdistichal plates smaller than the two interbranchials of the second row combined.

Ventral disk elevated, but slightly tapering, its upper margin curving abruptly to the base of the neck, which expands rapidly upward. It rises apparently far beyond the arms, and tapers in size as rapidly as it increases below.

Remarks: This species has been observed only in the form of casts. The dorsal cup alone has much the form of *E. crassus*, but is usually somewhat more slender with more elongate plates, but when the cast of the vault is preserved the two species are seen to be entirely distinct. *E. egani* differs from all the remaining associated species of the genus in its much elevated, somewhat conical ventral disk, as seen in the casts. This difference in form between the vaults of *E. egani* and *E. crassus*

may be well seen by a comparison of the accompanying figures of the two species.

Locality—Bridgeport.

Eucalyptocrinus obconicus Hall, pl. vii, fig. 8.

1867. *Eucalyptocrinus obconicus*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., p. 323, pl. xi, fig. 1.
 1870. *Eucalyptocrinus obconicus*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., Rev. Ed., p. 365, pl. xi, fig. 1.
 1885. *Eucalyptocrinus obconicus*. Wachsmuth and Springer, Rev. Palæocr., pt. III, p. 133.
 1897. *Eucalyptocrinus obconicus*. Wachsmuth and Springer, N. Am. Crin. Cam., vol. I, p. 353, pl. lxxxiii, fig. 13.

A small species, known only from internal casts of the dorsal cup. Dorsal cup obconical, elongate, very slender and pointed below, much higher than wide. This species differs from all others of the genus in the absence of a basal excavation, the basal plates forming instead a small obconical cup.

Basals small. Radials one and one half times as high as wide, the upper sloping faces very short. First costals quadrangular, about as wide as high; the second pentagonal, as large or a little larger than the first. First distichals about equal in size to the second costals, those of the same ray in lateral contact; the second very small. First interbranchials the largest plates in the calyx, nearly twice as high as wide; the two in the second row shorter and narrower. Interdistichals small, angular below.

Remarks: This peculiar little species is not a common one in the fauna of our district, but it may always be easily recognized by its peculiar slender form with no basal concavity. Because of the lack of satisfactory specimens for illustration, the figure on plate vii is a copy from Hall's original illustration of the species.

Locality—Romeo.

Eucalyptocrinus nodulosus, n. sp., pl. vii, figs. 1-3.

1867. *Eucalyptocrinus crassus*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., p. 323, pl. xi, fig. 2.
 1870. *Eucalyptocrinus crassus*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., Rev. Ed., p. 365, pl. xi, fig. 2.

Calyx of moderate size, dorsal cup subhemispherical, truncated below; basal excavation pentagonal, broad and moderately deep, with a small columnar facet placed in a secondary excavation. Plates convex, ornamented with small, thickly-placed rounded nodes.

Basals large, in the bottom of the basal excavation, but clearly visible beyond the columnar facet. Radials hexagonal, slightly longer than wide, the proximal half bent abruptly inward to form the sides of the basal concavity and grooved longitudinally, so that the angles of the pentagonal concavity are directed radially, distal half of the plates sloping outward and upward. First costals quadrangular, wider than high; the second hexagonal, about as high as wide, a little larger than the first. First distichals pentagonal, smaller than the second costals; second distichals smaller than the first. First interbrachials a little higher than wide, followed by two plates in the second row, which are very high and narrow. Interdistichal plates resting upon the truncated upper ends of the second costals a little smaller than the two second interbrachials combined.

The vault, partition walls and arms not preserved.

Remarks: The ornamentation of this species approaches *E. asper*, but it is distinguished from that species by the rather broadly truncate base with the broad, pentagonal, angular basal excavation, at the center of which is the small excavated columnar facet. It is described from a squeeze in the collection of Mr. W. R. Head, taken from the natural mould which is said to be in the collection of the late Dr. James Hall of Albany, N. Y.

Among the specimens from Bridgeport and other localities are many internal casts of a species of *Eucalyptocrinus*, which differ from the associated casts of *E. crassus* in their shorter dorsal cup with a rounder base and a broader basal cavity. They also differ from *E. crassus* in never attaining so large a size as that species sometimes does. These specimens are probably the casts of *E. nodulosus*, and will be so considered until something to the contrary is proved. Hall's illustration of *E. crassus* from Racine, Wis., is one of these internal casts, and is here referred to the new species, *E. nodulosus*.

The species is of particular interest, because the form of the basal concavity, and the large size of the basal plates, seem to indicate a transition between the genera *Eucalyptocrinus* and *Callicrinus*.

Localities—Bridgeport and Romeo.

Eucalyptocrinus asper, n. sp., pl. v, figs. 4-7.

Dorsal cup, the only portion of the species observed, depressed subhemispherical or saucer shaped, as wide or wider

than high. Basal concavity small and moderately deep. Surface of the plates flat and thickly covered with rather coarse, irregularly scattered nodes.

Radials of moderate size, rapidly tapering to their proximal ends, directed horizontally except at their extreme proximal ends, which take part in the basal concavity. First costals quadrangular, one-and-one-half times as wide as high; the second hexagonal, about equal in size to the radials, truncated at the distal end by the interdistichal plates. First distichals as large as, or a little smaller than, the last costals; the second distichals smaller than the first. First interbrachials larger than the radials, nearly as wide as high; those of the second row together smaller than the first. Interdistichals subrhomboidal, the upper and lower ends truncated, smaller than the two second interbrachials together. All the plates above the radials curving rapidly upward so that at the top the sides of the dorsal cup are nearly vertical.

Ventral disk unknown.

Remarks: This species is one of the most abundant ones of the fauna, but is rarely preserved otherwise than as internal casts. It is the species that has commonly been identified as *E. cælatus*. Wachsmuth and Springer* have shown that the Waldron *E. cælatus* is quite different from the true *E. cælatus* from the New York Niagara, and have referred the Waldron species to Miller's *E. elrodi*. The Chicago species comes nearer being the *E. elrodi* as interpreted by Wachsmuth and Springer than any other described species, but it possesses some characters distinguishing it from that one which are believed to be of specific value. The nodes with which the plates are thickly studded are coarser than in *E. elrodi*, and never show the tendency of running together and forming low, wavy ridges. The columnar facet and the basal concavity also are much smaller than in *E. elrodi*, and the concavity has not been observed surrounded by the ring-like projection upon the radial plates which is so often present in that species.

Localities—Bridgeport and Hawthorn.

Eucalyptocrinus ornatus Hall, pl. vi, figs. 5-6.

1861. *Eucalyptocrinus ornatus*. Hall, Rep. Prog. Geol. Surv. Wis. for 1860, p. 20.

1865. *Eucalyptocrinus ornatus*. Winchell and Marcy, Mem. Bost. Soc. Nat. Hist., vol. I, p. 91.

* N. Am. Crin. Cam., Vol. I, p. 340.

1867. *Eucalyptocrinus ornatus*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., p. 329, pl. xi, figs. 4-5.
1870. *Eucalyptocrinus ornatus*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., Rev. Ed., p. 366, pl. xi, figs. 4-5.
1885. *Eucalyptocrinus ornatus*. Wachsmuth and Springer, Rev. Palæocr., pt. III, p. 134.
1897. *Eucalyptocrinus ornatus*. Wachsmuth and Springer, N. Am. Crin. Cam., vol. I, p. 340, pl. lxxxii, fig. 10.

The dorsal cup, the only part of this species that has been observed, rather small, depressed subhemispherical or deep saucer shaped, wider than high. Plates convex, the sutures placed in shallow furrows; their surfaces ornamented with very fine wavy ridges passing out from the centers of the plates to their sides, but not continuing to adjoining plates. Basal concavity sharply pentangular, rather large and deep.

Basal plates small, situated in the bottom of the basal concavity. Radials of medium size, tapering rapidly to their proximal ends, which are abruptly turned inward to form the sides of the basal cavity, the distal portions of the plates extending out almost horizontally. First costals quadrangular, about one-and-one-half times as wide as high; the second costals much larger than the first, nearly as large as the radials, hexagonal, the distal end truncated by the interdistichals. First distichals two-thirds as large as the second costals; the second distichals smaller than the first, and the palmars still smaller. First interbranchials larger than the radials, nearly as wide as high; those of the second row together smaller than the first. The interdistichals subrhomboidal, truncated above and below, smaller than the two second interbranchials together.

Remarks: This common species generally occurs as internal casts, but a considerable number of specimens have been observed in which the plates are well preserved. In none of these has the ornamentation of the plates been observed to be so conspicuous as it is made to appear in Hall's original figure of the species, it being generally of so fine a character that it can only be observed when the specimen is held in such a position that the light strikes it at just the proper angle. The sharply pentangular basal concavity is also a feature not well shown in Hall's illustration. Notwithstanding these differences, there can be little doubt of the accuracy of the identification of the Chicago specimens, because of their great abundance, and because of the almost exact similarity in general form and size with Hall's species.

In general form *E. ornatus* is almost exactly like *E. asper*, but besides the difference in the ornamentation of the plates, it constantly differs from that species in its smaller size, and in its larger and deeper pentangular basal concavity. If these characters are kept in mind little difficulty will be experienced in distinguishing the internal casts of the two species. The internal casts of *E. ornatus* may be distinguished from specimens of *E. depressus* in the same state of preservation, by the much broader and deeper basal cavity in the latter species, and in its more vertical sides. The internal casts of all three of these species show considerable variation, and in a large collection of specimens almost a complete series, with all intermediate forms, may be selected, ranging from the small specimens of *E. depressus* with the broad basal cavity, through *E. ornatus*, to the larger specimens of *E. asper* with the small basal cavity. Most of the specimens, however, can be quite readily placed in one of the three species.

Localities—Bridgeport and Romeo.

Eucalyptocrinus rotundus S. A. M., pl. v, fig. 3.

- 1882. *Eucalyptocrinus rotundus*. S. A. M., Jour. Cinn. Soc. Nat. Hist., vol. V, p. 82, pl. iii, figs. 4, 4a-c.
- 1885. *Eucalyptocrinus rotundus*. Wachsmuth and Springer, Rev. Palæocr., pt. III, p. 134.
- 1897. *Eucalyptocrinus rotundus*. Wachsmuth and Springer, N. Am. Crin. Cam., vol. I, p. 350.

Body, with the partition walls attached, small, subglobose. The inner cavity, exclusive of the tubular prolongation of the vault, wider than high.

Dorsal cup low saucer shaped, the basal concavity small. Radials wider than long, their upper faces concave. First costals twice as wide as high; the second about the size of the first, a little higher at the median line, the distal ends truncated by the interdistichals. First distichals almost as large as the costals. The form of the other plates undeterminable.

Ventral disk depressed but higher than the dorsal cup, the sides in the cast nearly vertical below, bending abruptly inward above to the base of the tubular prolongation. Ten prominent keel-like ridges pass from the base to the summit of the vault, starting from the interbrachial and interdistichal spaces. Tubular prolongation thick, the sides subparallel from base to summit.

Remarks: The specimen to which Miller gave the name *E.*

rotundus is probably, as suggested by Wachsmuth and Springer, but an immature individual of some other species. This cannot be certainly determined, however, from the material at hand, and so for the present Miller's name will be provisionally retained.

Locality—Bridgeport.

Eucalyptocrinus depressus S. A. M., pl. vii, figs. 5-7.

1880. *Eucalyptocrinus depressus*. S. A. M., Jour. Cinn. Soc. Nat. Hist., vol. III, p. 232, pl. vii, figs. 1, 1a-b.

1885. *Eucalyptocrinus depressus*. Wachsmuth and Springer, Rev. Palæocr., pt. III, p. 133.

1897. *Eucalyptocrinus depressus*. Wachsmuth and Springer, N. Am. Crin. Cam., vol. I, p. 349, pl. lxxxiii, figs. 3, 4a-b.

Body of moderate size, subcylindrical, twice as high as wide, a little tapering to the upper end, distinctly flattened and concave at the poles. The height of the calyx, as observed in the casts, exclusive of the tubular prolongation, is about equal to the greatest width across the first distichals, with the dorsal cup and the tegmen about equal in height. The tubular prolongation above, almost as long as the rest of the calyx, widening at both ends.

Dorsal cup almost twice as wide as high, the distal part of the radials and the extreme proximal ends of the first interbrachials forming the truncated bottom, the distal part of the latter and the first costals gently curving upward, the succeeding plates vertical. Plates a little convex, their surface apparently rugose. Basal concavity deeply and broadly funnel shaped, the basals constituting but little more than the bottom part.

Radials slightly longer than wide, their distal half more or less horizontal in position, and but slightly visible from a side view, the proximal half forming the slanting sides of the basal concavity. First costals twice as wide as long, a little shorter than the second at the median line, the distal end of the latter slightly truncated by the interdistichals. First distichals about a third smaller than the upper costals; the second ones half the size of the first, their upper angles quite obtuse. First palmars very small and pentangular. First interbrachials subrotundate, as long as wide, those of the second row as long, but together narrower than the first, their upper ends rising to the bases of the second arm plates. The interdistichals have almost the form of the two upper interbrachials combined, but are somewhat smaller.

Partition walls of the vault nearly twice as long as the height of dorsal cup, moderately thin, the outer edges rounded to near the top, then slightly widening and curving abruptly inward and somewhat downward, so as to form a shallow depression around the summit. The upper ends inclose five rather large plates with a pentangular open space, the overlying plates not being preserved in the specimen.

Of the arms only the proximal plates are preserved, and these are comparatively long.

Remarks: This is a common and well characterized species in the Chicago fauna, but the plates are rarely preserved. The specimens usually collected are the internal casts of the dorsal cup alone. These casts present a considerable range of variation, but can generally be recognized by their moderate size with the broad and deep basal excavation. The size of the basal excavation varies somewhat, however, and it is sometimes difficult to draw a line between the internal casts of *E. depressus* with rather small basal excavations and the much depressed, intermediate sized specimens of *E. ornatus* with large excavations.

Locality—Bridgeport.

Eucalyptocrinus inornatus, n. sp., pl. vi, figs. 3-4.

Species known only from the dorsal cup. Dorsal cup much depressed, low saucer shaped, more than twice as wide as high. Basal concavity small and shallow. Surface of the plates flat, perfectly smooth.

Basals very small, included in the basal concavity. Radials small, directed horizontally, tapering rapidly to the proximal ends which form the sides of the basal concavity. First costals quadrangular, wider than high, a little smaller than the radials and directed nearly horizontally; the second hexagonal, truncated by the interdistichals, about as large or a little larger than the basals, curving upward from the horizontal position a little more than the first costals. The distichals curving upward more rapidly, the first ones nearly as large as the second costals, the second much smaller and followed by two small palmars. First interbranchials the largest plates of the calyx, higher than wide; the two second costals together about as large as the first. Interdistichal plates large, but not so large as the two second interbranchials combined.

Remarks: This species is remarkable for its much depressed form, its small basal concavity, and its unornamented

surface. As with the other species in the fauna, it is ordinarily preserved as internal casts. These casts approach most nearly in form and size to those of *E. asper*, but they can always be recognized by their more depressed form and by their basal concavity, which is even smaller than in that species. When the plates are preserved the two species cannot be confused because of the perfectly smooth surface of *E. inornatus* and the coarsely nodose surface of *E. asper*.

Localities—Bridgeport and Hawthorn.

Eucalyptocrinus magnus Worthen (?), pl. vi, fig. 7.

- 1875. *Eucalyptocrinus magnus*. Worthen, Geol. Surv. Ill., vol. VI, p. 501, pl. xxv, fig. 3.
- 1885. *Eucalyptocrinus magnus*. Wachsmuth and Springer, Rev. Palæocr., pt. III, p. 133.
- 1891. *Eucalyptocrinus gorbyi*. S. A. M., Adv. Sheets, 17th Rep. Geol. Surv. Ind., p. 39, pl. vii, figs. 5-6.
- 1892. *Eucalyptocrinus gorbyi*. S. A. M., 17th Rep. Geol. Nat. Hist. Ind., p. 649, pl. vii, figs. 5-6.
- 1897. *Eucalyptocrinus magnus*. Wachsmuth and Springer, N. Am. Crin. Cam., vol. I, p. 348, pl. lxxxii, figs 7-8.

A large species known in the Chicago fauna only from one internal cast of the dorsal cup. Dorsal cup depressed turbinate, a little more than twice as wide as high. Basal concavity of moderate size.

Radials, as exposed to view, wider than long, forming a shallow saucer-shaped cup. First costals somewhat smaller than the radials, with slightly convex sides. Second costals hexagonal, wider and longer than the first, the sloping upper faces unusually steep, the upper angles truncated by the interdistichals. First distichals about as large as the second costals; the second less than one-half the size of the first; the arm-bearing palmars trigonal and quite small. First interbranchials the largest plates in the cup, decagonal, subrhomboidal in outline, the sides more or less concave; the two plates in the second row together a little narrower than the first. Interdistichals large, but smaller than the two second interbranchials together.

Remarks: The one large individual which has been doubtfully identified as *E. magnus* does not agree in all particulars with the descriptions and illustrations of that species. It is possible, however, that the resemblance would be closer if the plates were preserved. The most important difference is the absence in the Chicago specimen of the peculiar elongation of the lower part of the dorsal cup, which gives to the true *E.*

magnus its drawn out appearance. The radial plates in the Chicago specimen are proportionately a little larger than in the authentic *E. magnus*; and the two second interbrachials in our specimen are a little narrower rather than a little wider than the first, as they are said to be in *E. magnus*. It is possible that the specimen illustrated is a very large individual of *E. asper*.

Locality—Hawthorn.

Genus 16 **CALLICRINUS** D'Orbigny.

In its general aspect, in the form of the calyx and arrangement of the plates, this genus closely resembles *Eucalyptocrinus*. The calyx has the form of a wine bottle with a long, slender neck and with a broad and deep concavity at the bottom; but the partition walls, instead of forming closed compartments to the full length of the arms, rise only part way and are not closed from above.

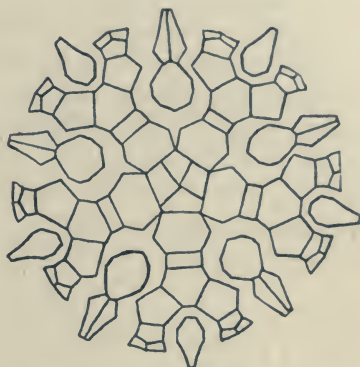


FIG. 47.—Diagram of *Callicrinus*.

As a rule the plates are highly ornamented, strongly nodose or extended into long spines. The dorsal cup is constructed of the same number of plates arranged in exactly the same manner as in *Eucalyptocrinus*; generally, however, the basal concavity is wider and is only partly filled by the column. In the construction of the ventral disk the two genera have close affinities; in both, the plates are arranged in four rings, and in both the first ring is composed of twenty plates, the second and third of four each, but the fourth ring in *Callicrinus* contains but four plates instead of ten, and these have no vertical wing-like extensions from their outer faces. The partition walls, of which there are twenty in this genus, are restricted to the plates of the first ring, and rise but little above their general height, never touching the plates of the second ring. Five of the partitions are supported by the interbrachials, five by the interdistichals, and the remaining ten are interposed between the ten others, resting upon the edges of two palmars. These latter partitions are formed by wing-like extensions

from the ten smaller plates of the first ring, they rise to the same height as the others, and separate the two arms which in *Eucalyptocrinus* occupy the same compartment. The plates of the second and third rings are either flat, the general curvature excepted, or they show some inclination to form faces of attachment for partition walls. The four plates of the upper ring constitute the upper end of the anal tube; they inclose a quadrangular anal opening, and are often extended horizontally into remarkable wing-like expansions which are variously lobed at the outer margin; the four of them combined sometimes forming a broad, disk-like or umbrella-like covering to the arms. The arms are robust throughout, closely folded, and composed from the second or third plate up of two rows of transverse pieces. The partitions by which they are separated rarely extend up higher than one third the length of the arms. Column round, the axial canal of medium size and pentangular.

Callicrinus cornutus (Hall), pl. viii, figs. 1-3.

- 1867. *Eucalyptocrinus cornutus*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., p. 322, pl. xi, figs. 8-10.
- 1867. *Eucalyptocrinus cornutus*, var. *excavatus*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., p. 322, pl. xi, figs. 6-7.
- 1870. *Eucalyptocrinus cornutus*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., Rev. Ed., p. 363, pl. xi, figs. 8-10.
- 1870. *Eucalyptocrinus cornutus*, var. *excavatus*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., Rev. Ed., p. 364, pl. xi, figs. 6-7.
- 1882. *Eucalyptocrinus cornutus*. Whitfield, Geol. Rep. Wis., vol. IV, p. 285, pl. xvi, figs. 5-8.
- 1885. *Eucalyptocrinus cornutus*. Wachsmuth and Springer, Rev. Palæocr., pt. III, p. 133.
- 1897. *Callicrinus cornutus*. Wachsmuth and Springer, N. Am. Crin. Cam., vol. I, p. 357, pl. lxxxiii, figs. 15-17.

Internal cast of the calyx elongate, subcylindrical below and conical above the arms, broadly truncated and broadly and deeply excavated at the base.

Dorsal cup wider than high, the sides nearly vertical. The excavation at the base extends nearly the full width of the cup and two thirds its height; the circumference sharply or obscurely pentangular, with straight, slightly convex or reëntering sides, the inner face grooved toward the angles, which are directed radially.

Basal plates rather small, occupying but half the depth of the basal concavity. Radials very large, the proximal half curving abruptly inward and forming a sharp edge upon which

the cup rests. Costals very small, the two together less than half the size of the radials; the first from two to three times as wide as long; the second a very little higher. Distichals, palmars, and interdistichals very small. First interbrachial unusually large, and as wide as long.

Ventral disk much higher than the dorsal cup, the sides rising vertically below, then sloping gradually to the summit.

Remarks: This species is not uncommon in the Chicago fauna, but it has not been observed with the plates preserved, and but rarely are the outlines of the plates upon the internal casts discernible. Well-preserved moulds of the exterior are occasionally found, and a gutta-percha cast from one of these is illustrated by Hall* upon which the radials are shown produced into long spines, and the remaining plates of the calyx are ornamented with prominent central nodes, which are connected with the nodes of adjacent plates by radiating ridges almost as highly elevated above the general level of the plates as the nodes themselves.

Localities—Bridgeport and Romeo.

Callicrinus longispinus, n. sp., pl. viii, figs. 4-5.

Dorsal cup, exclusive of the spines, basin shaped, with a broad, moderately deep basal excavation whose outer margin is distinctly pentagonal in outline. Each radial and first interbrachial plate produced into an enormous spine, whose length is greater than the width of the dorsal cup.

Basals forming a slightly concave disk at the bottom of the basal excavation, somewhat wider than the diameter of the column. Radials large, the proximal portion forming the sloping sides of the basal concavity, the outer portion of each plate produced into an enormous spine, longer than the width of the dorsal cup and sloping slightly upward. Along the median line of the inner sloping side of each radial is a narrow, elongate node with subparallel sides and rounded ends, reaching from the suture between the basals and radials to the margin of the basal excavation. First costals small, quadrangular, much wider than high; second costals small, pentagonal or nearly triangular. First distichals pentagonal, as large or larger than the costals; second distichals much smaller, pentagonal, much wider than high, supporting a pair of palmars which lead up to the arms. First interbrachials large, eight to

* Twentieth Report. N. Y. State Cab. Nat. Hist., pl. xi, figs. 10-11. This figure is also copied by Whitfield, Geol. Wis., Vol. IV, pl. xvi, fig. 7.

ten sided, dependent upon the form of the axillary costals, sub-circular in outline, produced into enormous spines similar in size, length, and direction to those of the radial plates; followed by two plates in the second row. Interdistichal plates much smaller than the two second interbrachials combined.

Ventral disk, partition walls and arms unknown.

Remarks: The internal casts of this species are not unlike those of *C. cornutus*, but it differs from that species in having the first interbrachials as well as the radials produced into long spines, all of which are larger and longer than the radial spines of *C. cornutus*. It is closely allied to *C. murchisonianus* from the Island of Gotland, but it differs from that species in having a well-defined pentagonal basal excavation, while in Angelin's illustration of the Gotland species the basal concavity is almost perfectly circular.

Locality—Joliet.

Callicrinus pentangularis, n. sp., pl. viii, fig. 6.

Dorsal cup pentangular, basin shaped, with a broad pentagonal, moderately deep basal excavation, the angles of the pentagon being in the middle of the radial plates. The five flattened sides of the cup rise abruptly from the outer margin of the basal excavation at an angle of about 45° , the adjacent sides meeting in a sharply elevated ridge along the median line of the ray.

Basal disk but little if any wider than the diameter of the column. Proximal ends of the radials grooved along the longitudinal median line, forming the sloping sides of the pentagonal basal concavity; distal portions of each plate in two parts, separated from each other by the radial ridge and from the basal excavation also by a sharply raised ridge. First costals quadrangular, twice as wide as high, sharply keeled along the longitudinal median line by the radial ridge. Second costals pentagonal, larger than the first, with a central node where the radial ridge divides. First distichals as large as the second costals, marked by a sharply elevated longitudinal median ridge; second distichals much smaller than the first. First interbrachials large, higher than wide, ornamented with an elongate central node which passes upward as two slight ridges to the second interbrachials. Second interbrachials rather small. Interdistichals small.

Remarks: This species is known only from a few fragments of natural moulds from which wax impressions have been made,

the illustration of the species being drawn from the most complete of these impressions. The characters of this species are so distinct that it cannot be confused with any of the other members of the genus.

Locality—Bridgeport.

SPECIES OF CALLICRINUS KNOWN ONLY FROM THE TERMINAL PLATES OF THE ANAL TUBE.

There are, in the Niagaran limestone of northern Illinois and southern Wisconsin, many impressions of large crinoid plates, triangular in general outline and variously lobed along one side. These plates are usually detached, but are sometimes preserved joined together in disk-like bodies constituted of four similar plates. When the impressions of the complete disks are preserved there is upon one side a central ring-like depression surrounding a cylindrical elevation, which is rounded over the top to the edges of a quadrangular fracture in the center. The opposite sides of the complete impressions are flat, with a central quadrangular fracture, and sometimes with the impressions of four slender spines nearly normal to the surface of the plates, one near the inner angle of each plate. The outer margins of the disks are variously lobed, though in all cases, unless the specimen be abnormal, the lobes of the four plates are symmetrical, and the lobing of each plate is bilaterally symmetrical in itself.

These disks have long been known to paleontologists and until recently have always proved to be a puzzle. In 1867 Hall* figured one of the disks, calling it the "calyx of a crinoidean," and gave it the name *Cryptodiscus*. In 1892 Miller† illustrated a single one of these triangular plates from St. Paul, Ind., but gave to it neither a name nor a satisfactory interpretation, merely suggesting that some collectors had considered it to be a part of the operculum of a coral. In November, 1897, Weller‡ published illustrations of several forms of these disks from Joliet, Ill., with the suggestion that they might be the fossil casts of the gastric cavities of medusæ, but in the following month the same author published some additional notes and illustrations based upon specimens from Racine, Wis., and showed conclusively that *Cryptodiscus* was but the terminal

* Twentieth Rep. N. Y. State Cab. Nat. Hist., pl. xl, fig. 8.

† Adv. sheets 18th Rep. Geol. Nat. Hist. Ind., p. 6, pl. i, fig. 7.

‡ Jour. Geol., Vol. V, p. 744.

§ Jour. Geol. Vol. V, p. 803.

ring of plates of the anal tube of *Callicrinus*, the cylindrical elevation in one side of the impression being the cast of the upper end of the interior of the anal tube, the quadrangular fracture at the center being the filling of the anal opening. The true nature of the disk was established by the finding of a specimen in which the disk was actually in position as the terminal ring of the anal tube of some member of this or a closely allied genus.

The only known genus besides *Callicrinus* to which these disks could belong is *Chicagocrinus*, a new genus described in this bulletin. The structure of the ventral side, so far as known, is identical in the two genera, and doubtless both of them possessed species in which the terminal ring of plates assumed this peculiar form.

As yet it has not been found practicable to correlate any particular form of disk with any particular species of either *Callicrinus* or *Chicagocrinus*, but as the specimens are so common in some localities, it seems best to describe the distinct forms and give to them names by which they may be designated. It is fully recognized that under these circumstances two names may be given to two distinct portions of the same species, one to the dorsal cup and one to the terminal anal disk, but until the two parts of the species can be correlated it is believed that it will be a convenience to give specific names to the disks, which may be dropped when the organisms are fully known. For the present the disks will all be referred to *Callicrinus*, although some may possibly, and probably do, belong to *Chicagocrinus*, no way yet being known by means of which the two genera can be distinguished from the disks alone.

Callicrinus desideratus, n. sp., pl. ix, fig. 2; pl. x, fig. 3; pl. xi, figs. 1-3.

1897. *Callicrinus*. Weller, Jour. Geol., vol. V, pp. 805-806, figs. 2-4, 7-8.

Known only from the impressions of the three upper rows of four plates each in ventral disk or anal tube. The lowest row have their lower ends imperfectly preserved; they flare out below, but above the middle of the plates the sides of the ring are subparallel; the upper ends of the plates are alternately higher and lower, and are truncated by the plates of the second ring. The plates of the second ring lie directly above those below, they are hexagonal and much higher than wide; those lying above the higher plates of the lower ring are widest near the top, the alternate ones are widest below; all four of the plates are of equal length, so that their upper ends are also

alternately higher and lower. The top ring of plates lies directly above those of the second ring; they are alternately longer and shorter, but all are shorter than those of the second row; the upper ends of all four plates curve over the top of the tube and completely cover it except for a quadrangular anal opening in the center. The upper, outer margins of the plates of the top row are expanded horizontally into a broad disk; that portion of the disk opposite each plate is prolonged into a broad lobe with subparallel sides, deeply notched at the distal end. Near the proximal angle of each plate of the top ring, upon the upper side close to the anal opening, a slender spine projects, nearly vertically, from the surface of the plate.

Remarks: The illustrated specimens of this species are from Racine, Wis., but are included here because they show, better than any other specimens which have been observed, the relationship between Hall's *Cryptodiscus* and *Callicrinus*. Figure 2, plate ix, is the specimen which first clearly showed this relationship; the cast of the upper tubular portion of the ventral disk is partially preserved in association with the mould of the disk-like expansion of the top ring of plates. Close to the distal angles of the two exposed plates of this ring are seen the impressions of the slender spines which surround the anal opening. Figures 1-2, on plate xi, show two lateral views of the best preserved of the internal casts of the tube-like portion of the ventral disk; and figure 3, plate x, shows a well-preserved impression of the upper surface of the terminal disk, with the impressions of the four slender spines which surround the anal tube. This last specimen is identified with the one in which the impression of the disk is preserved in place, solely on account of the spines surrounding the anal opening; it is of course possible that more than one species possesses this character, and that these two specimens belong to two different species, but more perfectly preserved material must be had before this can be decided. The diagram, figure 3, plate xi, is introduced to show the relations of the plates of the ventral disk in this species, and also for comparison with a diagram, figure 4, plate ix, of *C. costatus* His. of the typical species of the genus.

Locality—Racine, Wis.

Callicrinus corrugatus Weller, pl. xi, figs. 6-7.

1892. ? ? ? ? ? S. A. M., Adv. Sheets, 18th Rep. Geol. Surv. Ind., p. 6, pl. i, fig. 7.

1894. ? ? ? ? ? S. A. M., 18th Rep. Geol. Nat. Hist. Ind., p. 260, pl. i, fig. 7.

1897. *Cryptodiscus corrugatus*. Weller, Jour. Geol., vol. V, p. 747, figs. 1-2.

Known only from the terminal plates of the anal tube. These plates are large and have the general outline of the quadrant of a circle, the curved side being cut up into from eighteen to twenty narrow, pointed lobes, each lobe being the termination of one of the radiating corrugations of the plate. The corrugations extend from the periphery to about one half the distance to the proximal angle of the plate. The entire surface of the impressions, when well preserved, minutely pitted.

Remarks: This species is one of the commonest in northern Illinois, and so far as is shown by his illustration and description, Miller's St. Paul, Ind., specimen is not essentially different from those from Joliet.

Locality—Joliet.

Callicrinus hydei Weller, pl. viii, fig. 8; pl. ix, fig. 1; pl. x, figs. 1-2.

1897. *Cryptodiscus hydei*. Weller, Jour. Geol., vol. V, p. 748, figs. 3-4.

Known only from the terminal plates of the anal tube. The complete terminal ring of four plates has the outline of a Maltese cross, each arm of the cross being formed by one plate. The distal margin of each plate is divided into four, narrow, tapering, symmetrically arranged lobes; the two outer ones nearly half as long as the total length of the plate. Surface of the plates smooth.

Remarks: This species as usually preserved has the distal portion of the plates, as far as the bottom of the lobes, broken away. Otherwise from this imperfection in preservation such specimens as that illustrated on plate viii, figure 8, seem not to differ from the more perfect ones like that on plate ix, figure 1. The specimen illustrated on plate x, figure 2, differs from the others which have been observed in having the outer angles more widely diverging, but this can scarcely be taken as a character of specific importance. The complete specimen illustrated on plate ix, figure 1, has one plate which is apparently abnormal in having but three lobes upon the distal margin.

Localities—Romeo, Ill., and Racine, Wis.

Callicrinus digitatus Weller, pl. ix, figs. 3-4; pl. xi, fig. 5.

1897. *Cryptodiscus digitatus*. Weller, Jour. Geol., vol. V, p. 749, figs. 5-7.

Known only from the detached terminal plates of the anal tube. These plates are deeply trilobed on the distal margin, the primary lobes being much longer than the body of the

plate. In the specimen selected as the type the median lobe is undivided, but the most complete of the lateral lobes apparently divide distally into three secondary lobes, though only the bases of these lobes are preserved.

Remarks: Only a small number of specimens referable to this species have been observed. One specimen (plate ix, fig. 3), placed provisionally in this species, has the median lobe deeply bifurcate, and the lateral lobes more deeply and divergently lobed than in the type.

Locality—Lemont.

Callicrinus bilobus Weller, pl. x, fig. 4.

1897. *Cryptodiscus bilobus*. Weller, Jour. Geol., vol. V, p. 749, fig. 8.

The impression of a single perfect terminal plate of the anal tube of this species has been observed. It has the general form of the quadrant of a circle, but with two narrow, tapering, divergent lobes from the distal margin. Each of these lobes is marked longitudinally by a well-defined, rounded furrow, which extends from the tip of the lobe nearly to the proximal angle of the plate, becoming broader and more pronounced toward the angle. These two furrows divide the plate into three subequal triangular areas. Each of the triangular areas is ornamented upon its outer half by fine striæ, which diverge from the margins of the furrows.

Remarks: In the actual plates of this species the furrows above described, as seen in the impression of the plate, were, of course, rounded, elevated ridges, radiating from the center of the disk to the periphery.

Locality—Joliet.

Callicrinus bifurcatus, n. sp., pl. viii, fig. 7.

Known only from a single, nearly perfect impression of one of the terminal plates of the anal tube. The body or undivided portion of this plate is elongate and narrow; the distal portion is divergently bilobed, each lobe being nearly as wide at the base as the body portion of the plate, but only about two thirds as long.

Remarks: This is the smallest form of these disk plates that has been observed. The size of these terminal plates of the anal tube, however, do not indicate anything as to the size of the species to which they belong. It has something of the form of the terminal plates of the anal tube of *C. murchisonianus* as illustrated by Angelin. *C. longispinus* is the American spe-

cies most closely allied to the Swedish *C. murchisonianus*, and it is therefore possible that the plates described here as *C. bifurcatus* may belong with the dorsal cup described as *C. longispinus*.

Locality—Joliet.

Genus 17 **CHICAGOCRINUS**, n. gen.

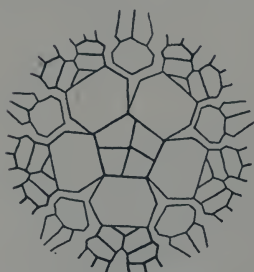


FIG. 48.—Diagram of *Chicagocrinus*.

In general aspect this genus is closely allied to *Callicrinus*, but has the costals of each ray reduced to a single small triangular plate.

Basal plates four, unequal, forming a flat disk with a diameter greater than that of the columnar facet. Radials large, hexagonal, the proximal ends in the same plane with the basals, the distal ends bent abruptly upward and forming the lower part of the sides of the dorsal cup. From their transverse angles the plates are produced into a collar-like folded expansion which entirely surrounds the basal margin of the cup. The costals reduced to a single plate in each ray, very small and triangular or quadrangular, their proximal faces narrower than the adjacent distal faces of the radials. The distichals larger than the costals; the outer lower corners of the first ones rest against the distal faces of the radials, on either side of the diminutive costals; each of the second distichals followed by a pair of palmars. The interbrachials and interdistichals are as in both *Eucalyptocrinus* and *Callicrinus*; the former consist of three plates in each interradius, one large one below with two high and narrow ones in the second row; the latter consist of a single plate in each ray, having the general form and size of the two interbrachials combined.

The ventral disk, so far as preserved, is identical with that in *Callicrinus*. The individual plates have not been observed above the first row, but each of these is extended into one of the twenty compartment walls which only reach a part of the way to the summit.

Remarks: The chief generic character of *Chicagocrinus* is found in the number and form of the costals, which are reduced to a single diminutive plate in each ray, instead of the two plates which are always present in both *Callicrinus* and *Eucalypt-*

tocrinus. *Chicagocrinus* also differs from both of these other genera in having a perfectly flat base, the apparent excavation being due entirely to the collar-like expansion of the radials.

It is entirely possible that the terminal ring of plates in the anal tube of some or all of the species of *Chicagocrinus* was expanded into a horizontal disk, as was sometimes the case in *Callicrinus*; and some of the species of *Callicrinus* recognized from these disks alone may eventually prove to belong to *Chicagocrinus*.

Two species are here recognized, but specimens too imperfect for description have been observed, which indicate one or more additional species of the genus.

***Chicagocrinus ornatus*, n. sp., pl. vii, fig. 9.**

Dorsal cup basin shaped, with a rim-like extension of the radials from the lower lateral margin; wider than high; the pseudo-basal concavity formed wholly by the extension of the radials.

Basals not observed. Radials hexagonal, the largest plates of the dorsal cup, the proximal half extending in a horizontal direction, the distal half bent abruptly upward and forming the lower portion of the flaring sides of the cup. From the angle which divides the radials transversely, each plate is produced into a thickened wing-like, subhorizontal extension, which in the middle forms a conspicuous node excavated beneath. These extensions of the radials are in contact laterally, and form the sides of the pseudo-basal concavity. Costals small, quadrangular, the distal angle being slightly truncated by the interdistichals, about as high as wide, the proximal face much narrower than the distal face of the radials. First distichals larger than the costals, pentagonal, wider than high, resting upon the costals and the outer portions of the distal faces of the radials; second distichals a little smaller than the first, wider than high, supporting two series of palmars. First interbrachials large, strongly nodose, and joined with the radials and the second interbrachials by conspicuous radiating ridges; the proximal angle of the plates at the point of contact with the two adjacent radials, situated in deep rounded pits formed by the elevation of the radial rim and the radiating ridges passing from the radials to the first interbrachials. Second interbrachials high, broad below but very narrow above, depressed between the adjacent palmars. Interdistichals small,

resting upon the slightly truncated distal ends of the costals, depressed between the adjacent distichals and palmars.

Ventral disk but partially known. The plates of the first ring are extended into twenty vertical partition walls, which reach only part way to the summit as in the genus *Callicrinus*. These partition walls are placed above the interbrachial, interdistichal, and interpalmar spaces of the dorsal cup.

Remarks: The distinguishing features of this species are its nodose and ornamented plates, and the truncated distal angle of the diminutive costals. The dorsal cup is proportionally more depressed than *C. inornatus* and the extension of the radial plates is thicker and more massive.

Locality—Bridgeport.

Chicagocrinus inornatus, n. sp., pl. vii, figs. 10-12.

Dorsal cup, exclusive of the rim-like extension of the radials, basin shaped, wider than high, the pseudo-basal concavity formed entirely by the extension of the radials. With the exception of the radials all the plates of the cup are flat and unornamented.

Basals large, forming a flat pentagonal disk twice as wide as the diameter of the columnar facet. Radials hexagonal, the largest plates in the cup, the proximal half extended out in a horizontal direction and forming an extension to the flat basal disk, the distal half bent abruptly upward, and forming the lower portion of the flaring sides of the cup. From the angle which divides the radials transversely, each plate is produced into a broad, wing-like extension, which bends down in a nearly vertical direction at the sides, but in the middle bends downward and outward, forming a Δ -shaped ridge or node above, and a rounded trough below; the outer end of the node is produced into a spine. The wing-like radial expansions are in contact laterally and form the sides of the pseudo-basal concavity. First costals very small, triangular, wider than high, much narrower than the radials, the bounding sutures situated in narrow groove-like depressions. First distichals much larger than the costals, hexagonal, wider than high, resting in part upon the lateral portions of the distal faces of the radials, and in part upon the costals; second distichals as large as the first, hexagonal, wider than high, supporting the second interbrachials as well as the palmars above. Each second distichal is followed by two series of palmars. First interbrachials large, octagonal, subcircular in outline, followed by two long,

narrow plates in the second row. Interdistichal plates angular below, resting between the first and second distichals and the inner series of palmars, smaller than the two second interbrachials combined.

Ventral disk, partition walls, and arms unknown.

Remarks: This species may be easily distinguished from *C. ornatus* by its flat, unornamented plates, by its thinner radial extensions, and by the relatively deeper dorsal cup.

Locality—Joliet.

Family VII. BATOCRINIDÆ.

Genus 18 PERIECHOCRINUS Austin.

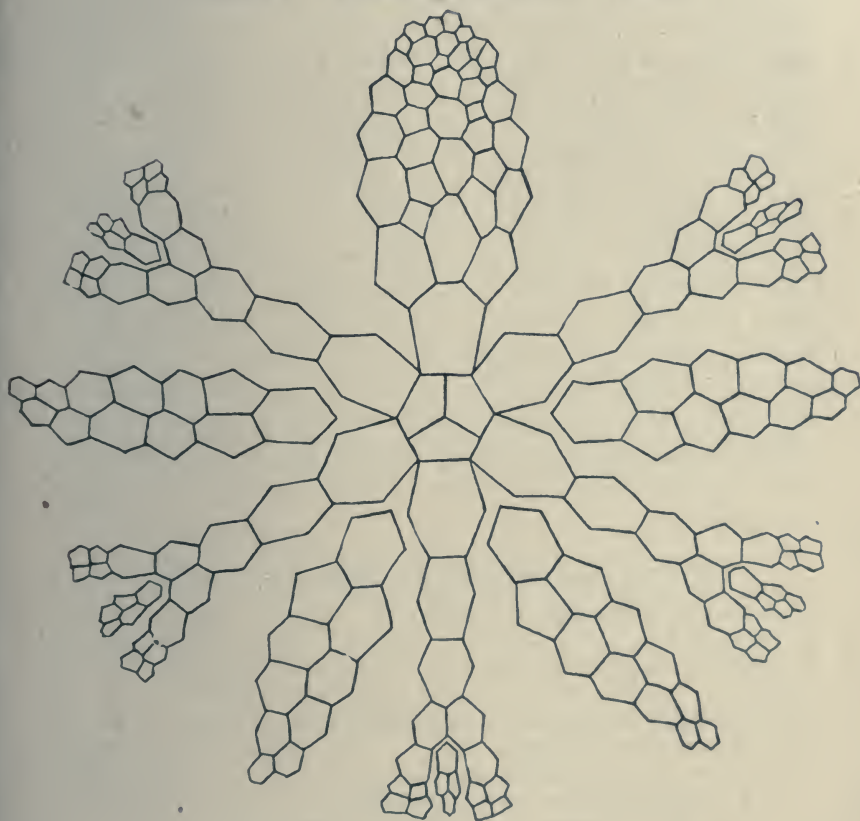


FIG. 49.—Diagram of *Periechocrinus*.

Calyx large, elongate, bell or urn shaped. Plates thin, with their surfaces smooth or delicately sculptured; often the radial plates have a ridge passing from plate to plate, which

increases in prominence upward until it becomes identified with the free arms.

Basals three, equal, forming a deep cup, the columnar facet wide. Radials and costals long and narrow, constricted at their proximal and distal faces and sometimes merely connected by the point of an angle. Costals two, the first hexagonal and the second heptagonal. Distichals in series of two to four plates each, supporting a series of from two to six palmars except in a few cases where the arms are free above the distichals. Interbrachial and interdistichal spaces long and narrow, filled with a large number of plates. First interbrachials larger than the succeeding ones, supporting numerous rows of two plates each—rarely three, and these only in the upper rows—which pass imperceptibly into interambulacral pieces. Anal interradius much wider than the others; the first anal plate similar in form to the radials and in line with them, followed by three plates in the second row and from four to six in the succeeding rows. Interdistichals present, variously represented by from three to six plates. Ventral disk depressed, from moderately convex to almost flat, composed entirely of small irregularly arranged plates, apparently without orals or radial dome plates, except close to the arms, where the covering and side plates sometimes enter the margin. Anus subcentral. Column large, cylindrical, the axial canal moderately wide and circular. The arms long, slender, and rounded, constructed from their bases up of a double series of interlocking pieces, branching dicotomously. Pinnules slender and closely contiguous.

KEY TO THE SPECIES OF PERIECHOCRINUS.

- I. No palmars included in the dorsal cup. Two arms from each ray *P. chicagoensis*
- II. Palmars included in the dorsal cup. Four arms from each ray.
 - A. Dorsal cup constricted at or below the arm bases.
 - a. Calyx very large..... *P. marcouanus*
 - b. Calyx of medium size..... *P. necis*
 - B. Dorsal cup widest at the arm bases.
 1. Brachial plates in the dorsal cup marked by a radial ridge.
 - a. Calyx elongate *P. infelix*
 - b. Calyx short *P. urniformis*
 2. Brachial plates in the dorsal cup not marked by a radial ridge..... *P. egani*

Periechocrinus chicagoensis, n. sp., pl. xiii, figs. 7-8.

Calyx small for the genus, obovate, constricted below and deeply depressed between the arm bases, which stand out conspicuously in the casts.

Basals of medium size, forming a spreading cup. Radials higher than wide, the two lower lateral sides being much the longer. First costals higher than wide, two thirds as large as the radials. Second costals pentagonal, much smaller than the first, supporting the distichals on the upper sloping sides. Distichals small, free above the second or third plate. Interbrachial areas on a level with the rays below, deeply depressed between the arm bases and continuous with the interambulacral areas. First interbrachial plate intermediate in size between the radials and the first costals, followed by two rather large plates in the second row which extend up to near the tops of the second costals; the remaining interbrachials not recognizable. But one small interdistichal recognizable. Anal inter-radius wide, marked above by a more or less conspicuous rounded ridge which continues to the anal opening. Anal plate similar in size and shape to the radials, followed by three plates in the second row of which the middle one is the smallest, the lateral ones being similar in size and shape to the first interbrachials; the succeeding plates growing smaller upward, arranged in three irregular rows of four or five plates each.

Ventral disk nearly flat or slightly convex, deeply depressed between the arms. The ambulacral furrows are marked in the casts by five prominent ridges which bifurcate near the margin.

Arms, judging from the arm bases, two from each ray.

Remarks: Although this is one of the commonest crinoids in the Chicago fauna, it has never been given a specific designation. It differs from all the associated species of the genus in the absence of palmars in the dorsal cup, thus allowing but two primary arms from each ray, or ten altogether. It never attains a large size, and has not been observed with the plates preserved, and but rarely can the outlines of the plates be recognized upon the internal casts.

Localities—Bridgeport and Joliet.

Periechocrinus marcouanus (W. & M.), pl. xii, figs. 2-4.

1865. *Megistocrinus Marcouanus*. Winchell and Marcy, Mem. Bost. Soc. Nat. Hist., vol. I, p. 87, pl. ii, fig. 5.

1881. *Saccocrinus marcouanus*. S. A. M., Jour. Cinn. Soc. Nat. Hist., vol. IV, p. 167, pl. iv, figs. 1-1a.

1897. *Periechocrinus marcouanus*. Wachsmuth and Springer, N. Am. Crin. Cam., vol. II, p. 523, pl. 1, figs. 7a-b; pl. li, fig. 5.

Body large and elongate, sometimes reaching a length of 90 mm. and a width of 60 mm. at the widest point. Form sub-ovoid, greatest width at the first distichals, whence it contracts to the arm bases, sometimes with a moderate expansion again just below the arm bases. Interbrachial and interdistichal areas occasionally somewhat flattened or faintly depressed, producing a sort of angularity along the median line of the radial series, without forming an actual ridge until close to the arms. Surface of plates smooth, suture lines not grooved.

Basals comparatively small, forming a saucer-shaped, hexagonal cup. Radials and costals of nearly the same size and of similar form, their lateral faces sometimes concave to receive the convex sides of adjoining interbrachials. Second costals as long or longer than the first, the upper and lower faces narrow in both of them. Distichals two or three, decreasing in size upward, the first nearly as large as the costals. Palmars several, comparatively small. Interbrachial areas long and narrow, with one plate in the first row followed by from ten to twelve ranges of two plates each, which meet the plates of the vault. Anal interradius wide, first anal plate a little shorter than the radials, but wider at the upper face. The three plates of the second row generally followed by three plates in the third row, the succeeding plates being arranged irregularly in rows of four, five, or six plates each, which grow smaller as they approach the vault. Upon the ventral disk there is a well-defined anal ridge which ends in a subcentral proboscidiform protuberance with the anus at the upper end. Interdistichals consisting of a rather large plate resting between the sloping upper faces of the first distichals, followed by several rows of two plates each.

Ventral disk almost flat, covered exclusively with small polygonal plates. In the casts there appear ten well marked bifurcating ridges, which represent the subtegmina ambulacral grooves.

Arms, judging from the arm openings, four to each ray and arranged in pairs.

Remarks: This is one of the common species in the Chicago fauna, and is easily recognized by its elongate calyx, which is constricted as it approaches the arm bases. One form, which is believed to be but a variation of this species, is shorter, with

rapidly expanding sides below and with a sharp constriction at the summit of the cup, so that the diameter at the arm bases is considerably less than a short distance below.

The plates of this species are so thin, and the individuals often grow to such a large size, that frequently in the adult specimens the calyx appears to have grown in an abnormal and distorted manner because of its weight, and not uncommonly the base is bent to one side. The shorter variety of the species mentioned above has the appearance of having grown in that manner because of the inability of the plates to support the weight of the body.

Localities—Bridgeport, Lemont, and Joliet.

Periechocrinus necis (Winchell and Marcy), pl. xiii, figs. 5-6.

- 1865. *Megistocrinus necis*. Winchell and Marcy, Mem. Bost. Soc. Nat. Hist., vol. I, p. 110, pl. ii, fig. 6.
- 1881. *Saccocrinus necis*. S. A. M., Jour. Cinn. Soc. Nat. Hist., vol. IV, p. 172, pl. iv, figs. 3-3a.
- 1885. *Periechocrinus necis*. Wachsmuth and Springer, Rev. Palæocr., pt. III, p. 106.
- 1897. *Periechocrinus necis*. Wachsmuth and Springer, N. Am. Crin. Cam., vol. II, p. 524, pl. I, figs. 1a-b.

Calyx small or of medium size, pyriform or subcylindrical, from not much higher than wide to one and one half times as high as wide, obconical to the top of first or middle of second costals, greatest width at second costals, above which it contracts more or less rapidly to the arm bases. Sometimes the calyx is slightly angular along the rays, giving to the cross section a pentangular outline, but more commonly the cross section is subcircular.

Basals of medium size, more rapidly spreading than the parts above. Radials and costals occupying two thirds the height of the calyx, of nearly equal size, longer than wide, their upper and lower faces wider than usual in this genus. Distichals two, the first two thirds and the second one half as large as the costals. Palmars small, two or more in number. Interbranchials rather large, decreasing gradually in size, generally arranged in six rows, of which the upper ones are irregular and not readily recognized; the first plate, which is the size of the first costals, supports two plates in the second row and two or three in the succeeding rows. Interdistichals small, the single plate at the base supporting about two additional rows of two plates each. Anal interradius wide, the first anal plate as large as the radials; three plates in the second row, the mid-

dle one being smallest, and from three to five plates in the rows above.

Ventral disk almost flat, its diameter small owing to the constriction of the upper part of the dorsal cup; in the casts the whole surface is covered by the impressions of small irregular plates. The ridges upon the casts which represent the ambulacral furrows are rather broad and rounded. The arm openings are arranged in groups and form a circle around the disk. Anal opening subcentral, apparently not large.

Remarks: The type specimen of this species is an imperfect fragment in which the radial angles are more pronounced than usual. The specimens used by Miller and by Wachsmuth and Springer for illustration represent an extreme variety of the species, in which the lower portion of the sides of the dorsal cup flare rapidly and the upper part contracts rapidly to the arm bases. The more common form of the species, however, is rather slender and subcylindrical, and the contraction of the calyx below the arms is not very conspicuous. An examination of a large series of specimens shows that these two extremes grade into each other, so that they must belong to the same species.

Localities—Bridgeport and Hawthorn.

Periechocrinus infelix (Winchell and Marcy), pl. xiii, figs. 1-2.

- 1865. *Megistocrinus infelix*. Winchell and Marcy, Mem. Bost. Soc. Nat. Hist., vol. I, p. 110, pl. ii, fig. 7.
- 1881. *Saccocrinus infelix*. S. A. M., Jour. Cinn. Soc. Nat. Hist., vol. IV, p. 260, pl. vi, figs. 2, 2a-b.
- 1897. *Periechocrinus infelix*. Wachsmuth and Springer, N. Am. Crin. Cam., vol. II, p. 525, pl. I, figs. 2a-d.

Dorsal cup somewhat obconical, higher than wide, greatest width at the arm bases; sides convex, abruptly spreading from the basals to the top of the radials; the upper portion subcylindrical, sometimes a little spreading especially just below the arm bases. Surface of the plates nearly flat, slightly depressed at the margins so that the sutures are situated in narrow and shallow furrows. The plates of the brachial series marked by a narrow rounded longitudinal ridge extending from the radial plates to the arm bases. In the casts these ridges are sometimes nearly obsolete.

Basals small, forming a shallow hexagonal cup. Radials and costals rising to three fourths the height of the calyx. Length and breadth of the radials about equal. First costals

a little larger than the second; both of them longer than wide. Distichals two, two thirds the size of the axillary costals. Palmars two in each series, small. Interbrachial and interdistichal areas on a level with the adjoining brachials except near the arm bases, where they are somewhat depressed. First interbrachials as large as the first costals, followed by six or seven rows of two plates each which grow smaller upward. First interdistichals smaller than the distichals, followed by several rows of one or two plates each. Anal interradius wide, depressed between the arm bases. Anal plate similar in size and form to the radials; three plates in the second row and these followed by a large number of somewhat irregularly arranged plates.

Ventral disk low, convex, or nearly flat, interambulacral spaces depressed. The ambulacral grooves in the cast are represented by prominent ridges which bifurcate half way to the margin, and again close to the arm bases.

Arms, judging from the arm bases, four to each ray.

Localities—Bridgeport and Romeo.

Periechocrinus urniformis (S. A. M.), pl. xii, fig. 1; pl. xiii, figs. 3-4.

- 1881. *Saccocrinus urniformis*. S. A. M., Jour. Cinn. Soc. Nat. Hist., vol. IV, p. 170, pl. iv, figs. 2-2a.
- 1882. *Saccocrinus pyriformis*. S. A. M., Jour. Cinn. Soc. Nat. Hist., vol. V, p. 81, pl. iii, fig. 3.
- 1885. *Periechocrinus pyriformis?* Wachsmuth and Springer, Rev. Palæocr., pt. III, p. 106.
- 1885. *Periechocrinus urniformis*. Wachsmuth and Springer. Rev. Palæocr., pt. III, p. 106.
- 1897. *Periechocrinus urniformis*. Wachsmuth and Springer, N. Am. Crin. Cam., vol. II, p. 526, pl. 1, figs. 5a-b.

Calyx large, ovoid; greatest width across the arm bases which are somewhat projecting; plates gradually decreasing in size upward. In the casts the sutures are often marked by elevations, the central portion of the plate being concave.

Basals small, forming a rather shallow cup. Radials and costals nearly equal in size, their width across the middle equal to their height. Distichals two, the first three fourths and the second one half the size of the axillary costals. Palmars small, two or more in each series. Interbrachial and interdistichal areas on a level with the surrounding brachials, except close to the arm bases, where they form rather wide, well-marked depressions, which are continued upon the ventral disk. First interbrachials of about the same size as the first costals, succeeded

by six or seven rows of two plates each. First interdistichals resting within the notch of the first distichals, intermediate in size between the first and second distichals; succeeded by two or three rows of one or two plates each. Anal interradius remarkably wide. Anal plate closely resembling the radials in form and size; followed by three rather large plates in the second row, which are followed by six or more rows with four or five plates each. The plates of the anal interradius, as they approach the arm bases, sometimes form a rounded, conspicuous ridge, which continues upon the ventral disk and leads to the anal opening.

Ventral disk subhemispherical or flattened, composed of rather uniform plates of moderate size. In the casts the ambulacral grooves are marked by prominent ridges which bifurcate half way out to the margin and again close to the arm bases.

Arms arranged in pairs, there being two pairs, or four arms to each ray.

Remarks: This species resembles *P. infelix*, and is perhaps but a variety of it. It may be distinguished, however, by its proportionally shorter and broader calyx. Normally the species has a flat ventral disk. In one specimen illustrated by Wachsmuth and Springer, and also on the accompanying plate xii, figure 1, the dome appears subhemispherical, and the anal interradius is marked by a conspicuous rounded ridge which continues across the ventral disk to the anal opening. This appearance of the specimen, however, is due to distortion by crushing.

Locality—Bridgeport.

Periechocrinus egani (S. A. M.), pl. xiii, fig. 9.

1881. *Saccocrinus egani*. S. A. M., Jour. Cinn. Soc. Nat. Hist., vol. IV, p. 173, pl. iv, fig. 4.

1885. *Periechocrinus Egani*. Wachsmuth and Springer, Rev. Palæocr., pt. III, p. 106.

Dorsal cup somewhat obconical, higher than wide, the greatest width at the arm bases; sides convex, flaring most rapidly from the basals to the top of the radials, above the radials approaching more nearly toward a perpendicular direction, sometimes a little spreading at the arm bases. Surface of the plates smooth, rather strongly convex, sometimes with a slight pit-like depression in the center; the radial ridge, so common in the genus, almost or entirely absent. The sutures situated in well-defined furrows between the plates.

Basals wider than high, strongly convex in the lower part, forming a shallow hexagonal cup. Radials as high or higher than wide, hexagonal and heptagonal. First costals hexagonal, higher than wide, the upper and lower faces shortest; second costals heptagonal, as high or higher than wide, generally smaller than the first. First distichals much smaller than the costals, hexagonal, as high as wide; second distichals heptagonal or hexagonal, smaller than the first, supporting the palmars, which are very small. First interbranchials hexagonal, as large or larger than the first costals, widest below, followed by five rows of two plates each which successively diminish in size. Interdistichal spaces depressed, filled with three or more small plates.

Ventral disk nearly flat with the exception of a subcentral anal inflation or low proboscis, covered with numerous small polygonal plates.

Arms unknown, but judging from the openings four to each ray.

Remarks: *P. egani* is another species closely allied to *P. infelix*, and has been considered a synonym of that species by Wachsmuth and Springer. Upon examining the original types of the species in the Academy of Sciences' collection, besides additional material in the same and other collections, it has been thought best to consider the two species as distinct. The distinguishing characters of *P. egani* are the rather strongly convex plates and the absence of radial ridges. All of the specimens preserving the plates are also smaller than authentic adult specimens of *P. infelix*. From internal casts alone it is not possible to recognize the two species as distinct, and one of Miller's types which is an internal cast may as well be *P. infelix* as *P. egani*.

Localities—Bridgeport and Cicero.

FAMILY VIII. PLATYCRINIDÆ.

Genus 19 MARSUPIOCRINUS Phillips.

Calyx low, basin or saucer shaped; the dorsal side flat or slightly convex; the sides more or less vertical. Surfaces of the plates flat or convex, sometimes corrugated or ornamented by fine striations. Symmetry of the dorsal cup perfectly pentamerous. Costals and distichals included in the calyx, connected laterally by a single interbranchial plate.

Basals three, unequal, two large ones and one small one;

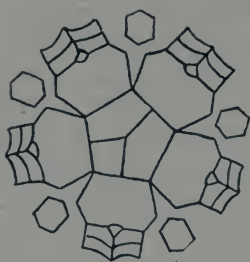


FIG. 50.—Diagram of *Marsupiocrinus*.

forming a flat or slightly convex pentagonal disk. Radials large, hexagonal, curving gently upward from the basals and with them forming a broad, shallow cup; the middle of the distal face slightly excavated for the reception of the costals. Costals one in each ray, very small, triangular, about as high as wide, with slightly convex sides, occupying from one fourth to one third of the distal face

of the radials. First distichals entirely enveloping, with the radials, the diminutive triangular costals; they are much larger than the costals but much smaller than the radials; they meet at their short, inner lateral faces above the apex of the costal, and rest with their proximal faces upon the distal faces of the radials and upon the costals. Above the first distichal there are either two series of palmars which give origin to twenty arms, or in some species other distichals which give origin to but ten arms. Each interbrachial space is filled by a single plate which is higher than wide and rests upon the upper sloping corners of the radials.

Ventral disk depressed hemispherical; the orals rather small, pushed anteriorly, and quite asymmetrically arranged. The ambulacral plates consist of regular series of covering plates which are separated from those of adjacent rays by rather large interambulacral plates. Anal opening subcentral.

Arms, two or four from each ray.

Column round, the axial canal pentagonal, rather large.

Marsupiocrinus chicagoensis, n. sp., pl. xiv, figs. 2-3.

Dorsal cup, the only portion of the species known, saucer shaped, more than twice as wide as high, the base flat, the sides convex. All the plates of the cup convex except the basals, and their surfaces smooth.

Basals spreading horizontally, forming a flat pentagonal disk which is variable in size; with a large, deeply excavated, circular, concave, columnar facet, which in those specimens with the smaller basal disk is nearly as wide as the disk itself. Radials convex, large, hexagonal, much wider than long, standing out nearly horizontally from the basal disk; the proximal margins thicker than the basals, so that the basal disk is apparently depressed between the proximal ends of the radials; the

median portion of the plates along the distal margin, just underneath the costals, is elevated into a sort of triangular node about equal in size to the costals. Costals very small, triangular, nearly vertical in position, about as wide as high, occupying less than one third of the distal face of the radials. First distichals rather large and sublunate, nearly vertical in position, lying upon the distal faces of the radials and the sloping sides of the costals and meeting above the latter plates. Second distichals triangular, smaller than the first, and lying in their outer, sloping, concave faces. Interbrachial plates large, much higher than wide, resting upon the upper sloping faces of the radials, and between the distichals of adjacent rays, nearly vertical in position.

Remarks: The distinguishing features of this species are its flat basal disk depressed between the proximal ends of the radials, with its very large and deeply excavated columnar facet, and its unornamented plates with the triangular node at the middle of the distal margin of the radials.

Locality—Chicago.

Genus 20 **PLATYCRINUS** Miller.

Calyx oblong, globose or pyramidal; the dorsal cup subcylindrical, conical, bowl shaped, or discoid. Basals three, large, two of them equal, and twice as large as the third; the latter rhomboidal, placed with its upper angle between the anterior and the left antero-lateral radials; the plates so closely anchylosed that they cannot be separated, often not leaving even a trace of the suture line. Radials very large; their upper faces partly excavated, and forming a well-defined facet for the reception of the brachials; the limbs on both sides of the facets more or less sloping, forming notches which support the interradial plates. Costals one, exceptionally two, united with the radials by an almost rigid suture, the plates often so small as to be buried within the facets, so that the distichals touch the radials by their outer margins. The distichals, and all the higher orders of brachials to the last bifurcation, generally consist of two plates each, of which the upper one is axillary. These plates have the form of free arm plates, being rounded



FIG. 51.—Diagram of *Platyocrinus*.

on the back, but the lower ones are suturally connected with the plates of the disk, and in some species also with the radials, or with their fellows of the opposite side of the ray, and are therefore rigid.

Ventral disk pyramidal, convex or almost flat. Orals slightly eccentric, and more or less asymmetrical. Ambulacra composed of two series of covering plates which are exposed upon the disk. The interambulacral plates variable in number, except the first row which is in part interbrachial, and always consists of three plates transversely arranged, the middle one of which is the larger. Anus eccentric, either opening directly through the disk, or located at the top of a protuberance, or sometimes at the end of a tube.

Joints of the column elliptical in outline, their articulation bifacial, there being a well-defined ridge following the longer diameter of the joints. Column of moderate length, twisted throughout its whole length so that motion in all directions is permitted.

Platycrinus (?) *dubius*, n. sp., pl. xiv, fig. 4.

Dorsal cup deep, much higher than wide, the sides above the basal cup subparallel, slightly constricted just below the tops of the radials.

Basal cup obconical, its height equal to about two-thirds of its width. Radials almost twice as high as wide, straight across the top, not notched for the insertion of the interradians; the arm facets very small.

Remarks: Only the internal casts of the dorsal cup of this species have been observed, but such specimens are not uncommon. In specimens preserving the plates the general proportions would doubtless be somewhat altered.

There is some doubt as to the correct generic position of this crinoid. In the arrangement of the plates it seems to agree exactly with the genus *Platycrinus*. The sutures in the basal cup have not been observed with entire satisfaction, but from the examination of a considerable number of fairly preserved specimens, there seem to be three of them, dividing the cup into three unequal plates, two larger ones and a smaller one, as in *Platycrinus*. The radials also are arranged as in that genus. The character which seems most antagonistic to such a generic reference of the species is the absence of any notches between the radials at their distal ends for the reception of the interradian plates, the plates having the appearance of being

cut square off, with no sign of any succeeding plates except those of the arms. It is possible that more perfectly preserved material will necessitate the removal of the species, not only from the genus *Platycrinus*, but from the order *Camerata*. If it really is an Inadunate crinoid it will probably necessitate the establishment of a new genus for its reception.

Locality—Bridgeport.

Family IX. CROTALOCRINIDÆ.

Genus 21 CROTALOCRINUS Austin.

(See figure 3, page 19.)

When the arms are closed this crinoid resembles an elongate bud with folded leaves; when they are fully opened it is wheel shaped, with five lanceolate areas between the bases of the rays. Calyx subglobose, flattened above.

Infrabasals five, large, pentagonal, of uniform size. Basals five, very large, extending three fourths the height of the calyx, all hexagonal except the posterior one, which is higher than the others and has the distal angle truncated for the support of a comparatively small, quadrangular anal plate which rests between the radials.

The radials are much wider than high, their distal faces thickened, either concave or straight, and occupied by small, shallow depressions for the reception of the costals and higher brachial plates, which to the third or fourth order rest partly upon this plate. There is a single, very small triangular costal in each ray, which occupies a space at the middle of the radial and is at times scarcely visible dorsally; from its dorsal side the plate is very long and slender, and is bent upward almost to a right angle, so as to bring the face opposite the one exposed dorsally into a horizontal position, and on a level with the vault. The distichals rest against the sloping faces of the costals and upon the radials; they are axillary plates and support the palmars, which also rest partly upon the distal face of the radials. The first order of post-palmars occasionally rests upon the dis-

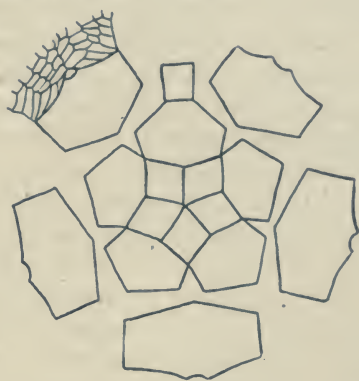


FIG. 52.—Diagram of *Crotalocrinus*.

tal face of the radials. All of these plates in various ways are firmly attached to the radials, and are united suturally with one another; and all of them, by curving upward and inward, extend from the dorsal to the ventral surface of the calyx, and form a sort of transition between true brachial plates included in the calyx and arm plates, in a similar manner to the corresponding plates of the *Platycrinidæ*. The plates are wedge-form, thinning out toward the dorsal cup, where they are exposed as mere points or lines, and where one or more of them are sometimes altogether invisible. Their larger upper faces, which are exposed ventrally, are deeply grooved for the reception of the ambulacra, and are only partially exposed when the covering plates are in position. The brachial plates above the fourth order are not in contact with the radials, and may be regarded as true arm plates, which they resemble in form and in point of mobility.

The arms are long and branch frequently; the branches are connected laterally by points of attachment from near the middle of each joint, with open spaces between them, and form a sort of network around the calyx with innumerable elongate meshes. In some species this network is continuous around the calyx, but in others the rays are separated, and form five broad, reticulate leaves which overlap each other when closed over the calyx. The articulation of the arm plates is by strong muscles and fossæ rather than by suture. The arm joints, owing to their lateral projections, have the form of a cross with short arms; they are long, flat on the dorsal side, laterally compressed, with straight sides, and are deeply grooved on the ventral surface for the reception of the ambulacra; they are disposed in regular dichotomizing longitudinal rows, as well as in concentric rows, the points of union occupying the same line all around the calyx. The ambulacral furrows are arched by alternately arranged covering pieces, three or four upon each side of the arm joint.

Each brachial plate is pierced by a very large dorsal axial canal, and the axillary ones by two, which meet in the middle of the plate; they ramify to the ends of the arms, and all converge into one in the costals, thence passing downward along the inner surface of the radials toward the basals.

Ventral disk flat, on a level with the spreading arms; composed of five oral plates asymmetrically arranged, besides additional ambulacral and interambulacral plates. The posterior

oral is large, somewhat elongate, its anterior end resting between the truncate faces of the four others, and its posterior end against small anal plates. The four smaller orals vary from elongate-clavate to almost regularly hexagonal. Outside the orals, and alternating with them, are five somewhat irregular axillary radial plates, giving off two sets of ambulacral plates in lateral contact. Between the ambulacral plates and abutting against the four smaller orals are two or more interambulacral plates, the inner ones the larger. Between the ambulacral plates and against the large posterior oral are numerous small anal plates which embrace the anal opening, the outer ones of which face the anal plate of the dorsal cup. The anal opening is eccentric and its form varies among the different species, being extended into a tube or placed at the top of a small protuberance. The tube apparently reached to a considerable height, and seems to have been composed of several rows of transverse pieces, longitudinally arranged, with a large octagonal cavity.

Column very large, terminating in numerous rootlets. Axial canal large, round.

Crotalocrinus americanus, n. sp., pl. xiv, fig. 1.

Known only from an imperfect radial plate and the fixed brachials of a single ray. From the proportions of this specimen the calyx of which it formed a part must have been about $1\frac{1}{4}$ inches in diameter. The profile view of the specimen, from the base of the radial to the top of the highest fixed brachials, is a gentle concave curve.

Infrabasals and basals unknown. Radials much wider than high, the exact outline and proportions not preserved, the distal face divided into small, shallow depressions for the reception of the fixed brachials, the surface ornamented with very fine irregular papillæ, or wavy ridges. The dorsally exposed faces of the fixed brachials very small, always much wider than high, the sutures between them placed in narrow, shallow grooves; their bifurcations unequal, generally one of the sloping faces of the axillaries being considerably longer than the other. Costal plate minute, triangular, occupying a shallow and narrow depression in the center of the distal face of the radial. Distichals much wider than high, their inner sides abutting against the costal, the whole of the proximal sides occupying shallow depressions in the radials on either side of the small depression occupied by the costal; more than twice as wide as the costal, axillary, the outer sloping side much shorter

than the inner. Palmars larger than the distichals. The two inner ones in lateral contact on the median line of the ray, surrounding the distal angle of the costal; axillary, the upper sloping sides nearly equal, and giving rise to two series of post-palmars, the outer series of which contains three plates and then becomes free from the calyx, and the inner series contains two plates, the second one being an axillary plate which gives rise to two post-palmars of the second order beyond which the plates are free. The two outer palmars are much wider than the median pair and abut against the outer sides of the distichals and median palmars, their whole proximal sides being in contact with the radial; followed by second axillary palmars whose inner sides abut against the outer sides of the median palmars and the post-palmars, and whose outer ends are in contact with the radials. The two upper sloping sides of the axillary palmar are uneven, the outer one being much longer than the inner; it is followed by two series of post-palmars of the first order. The inner series contains three plates, above which the plates are free; the outer series contains two plates, the second one being axillary and supporting two post-palmars of the second order, beyond which the plates are free.

The dorso-ventral extension of the fixed brachials is very great, in the uppermost row generally about twice their width and many times their height. The dorsal canals of the brachial plates, as exhibited by impressions in the outer row of these plates are very large, their diameter being more than half the width of the plates.

Remarks: This is the first description of a species of *Crotalocrinus* from America, the remaining species of the genus being from the Silurian of Gotland, Sweden, and Dudley, England, and it is unfortunate that so interesting a crinoid should be known in America from so imperfect a specimen. Of the previously described species of the genus, the American species most closely resembles *C. rugosus*, but it differs from this species as illustrated by Wachsmuth and Springer* in the much less conspicuous ornamentation of the radials, and in a somewhat different arrangement of the fixed brachials above the palmars. The arrangement of the plates beyond the outer pair of palmars is the same in both species, but those beyond the median pair are differently arranged. In *C. americanus* there is a single plate in each of the median palmar series, while in

* Proc. Acad. Nat. Sci. Phil., 1888, pl. xix, figs. 2a-2b.

C. rugosus there are two plates in each of these series. In *C. americanus* the inner side of the axillary plate of this series is followed by two post-palmars of the first order, the second one being axillary and followed by a pair of post-palmars of the second order; the outer side is followed by a series of three post-palmars of the first order. In *C. rugosus* the arrangement of the inner and outer branches from these palmars is exactly reversed, the series of three post-palmars of the first order being given off from the inner side of the plate.

Locality—Bridgeport.

Order III. ARTICULATA.

Family X. ICHTHYOCRINIDÆ.

Genus 22. ICHTHYOCRINUS Conrad.

General form of the body, including the arms, ovoid to pyriform, with almost perfect pentamerous symmetry. Calyx bowl or cup shaped.

Infrabasals three, rudimentary, unequal, sometimes seen only within the calyx. Basals five, very small, their distal angles acute. Radials pentagonal, widest along the distal margin, angular at the proximal end. Costals two or three in each ray, quadrangular except the axillary ones which are pentagonal, wide and short; height about equal but rapidly increasing in width distally, the plates being wider at their distal than at their proximal margins. Distichals, palmars, and post-palmars similar in form to the costals, quadrangular in general outline except the axillary plates which are pentagonal, those of the same order of equal height and one half the width of the next order. Arms twenty to sixty or more, accumbent, unfolding at the tips and forming with the calyx an apparently solid structure; they are composed of single series of plates which are heavy, wider than high, quadrangular, usually with waving suture. Pinnules unknown. Interradial and anal plates generally absent or undeveloped on the outside; when present they are longitudinally arranged, but the anal side cannot be distinguished.

Ventral disk unknown. Column composed of very short

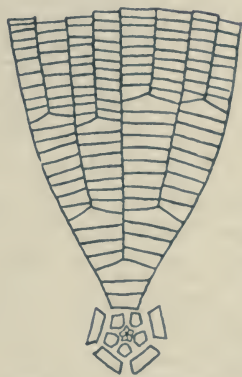


FIG. 53.—Diagram of *Ichthyocrinus*.

joints near the top, increasing gradually in length downward; axial canal of medium size, pentagonal.

Ichthyocrinus subangularis Hall, pl. xv, figs. 3-5.

- 1863. *Ichthyocrinus subangularis*. Hall, Trans. Albany Inst., vol. IV, p. 201.
- 1865. *Ichthyocrinus corbis*. Winchell and Marcy, Mem. Bost. Soc. Nat. Hist., vol. I, pp. 89 and 108.
- 1868. *Ichthyocrinus subangularis*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., p. 367, pl. xi, figs. 15-16 and p. 325.
- 1870. *Ichthyocrinus subangularis*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist. (Rev. Ed.), p. 367, pl. xi, figs. 15-16, and p. 429.
- 1879. *Ichthyocrinus Corbis*. Wachsmuth and Springer, Rev. Palæocr., pt. I, p. 34.
- 1879. *Ichthyocrinus subangularis*. Wachsmuth and Springer, Rev. Palæocr., pt. I, p. 35.
- 1879. *Ichthyocrinus subangularis*. Hall, 28th Rep. N. Y. State Mus. Nat. Hist., p. 137, pl. xvi, figs. 11-13.
- 1881. *Ichthyocrinus corbis*. S. A. M., Jour. Cinn. Soc. Nat. Hist., vol. IV, p. 175, pl. iv, fig. 5.
- 1882. *Ichthyocrinus subangularis*. Hall, 11th Rep. Geol. Nat. Hist. Ind., p. 268, pl. xv, figs. 12-13, pl. xvi, figs. 11-13.

Calyx elongate, turbinate or obconic below, becoming cylindrical above; angular above the base, when the plates are preserved, by the prominence of the radial series; base truncated for the articulation of the rather large column.

Infrabasals rudimentary, concealed by the column and rarely noticeable even in the internal casts. Basals appearing pentagonal above the junction with the column, their proportions varying from wider than high to higher than wide. Radials generally unequal, one or two small, pentagonal plates, the others larger and hexagonal. All the brachials are very short and wide, the axial ones are pentagonal, and all the others quadrangular except in some instances in the lower part of the calyx, where the plates of adjacent series are not exactly even, when one or both of the sides of the plates may be slightly angular. Costals two, rarely three, in each ray. Distichals four in each series. Palmars eight or nine in each series. First post-palmars more numerous than the palmars. No anal or interradsial plates present in the calyx.

Ventral disk unknown.

Remarks. This species usually occurs in the Chicago fauna in the form of internal casts, and in that condition of preservation it is a common crinoid. These specimens are pointed below and have a rough appearance, with the sutures between the

plates usually represented by thin, elevated straight ridges. The angularities of the radial series are not so pronounced as when the plates are preserved so that the cross section is nearly circular. Many specimens have the base bent to one side, a characteristic which is probably due to the weight of the body of the growing animal supported upon the stem.

The species was first recognized in the Chicago fauna by Winchell and Marcy, who described it under the name *I. corbis*. They had nothing but the internal casts to study, and founded their species upon these specimens; their type specimens are still preserved in the collection of Northwestern University, and show nothing more than hundreds of other specimens which have been collected at Bridgeport. Hall, who had a well-preserved specimen from Bridgeport, in which the plates were present, identified the species as his *I. subangularis* from Waldron, Ind., and there is no reason for believing that all of the internal casts do not belong to the same species.

At a later date S. A. Miller revived Winchell and Marcy's name for a specimen, preserving the plates, belonging to the Egan collection, now in The Chicago Academy of Sciences' collection. In this specimen the surfaces of the plates are not flat as in the one Hall illustrated, but are somewhat protuberant, and the basals have an angular surface. The specimen (plate xv, fig. 3) is a very small one, however, and it is entirely probable that this character of the plates is but a juvenile characteristic. Miller's statement that the angles of the pentagon formed by the basals (subradials) are directed radially is not confirmed by the specimen, the angles of the pentagonal disk formed by these plates being interradian in position. He also seems to think that the straight body may be a character of specific importance, but this can be only an individual variation probably due to the small size and weight of the body.

Localities—Bridgeport and Romeo.

Genus 23 **LECANOCRINUS** Hall.

General form of the body, with arms attached, subglobose to pyriform. Dorsal cup bowl-shaped, unsymmetrical, plates heavy.

Infrabasals three, large, unequal, two of them being twice as large as the third, the smaller one being directed between the posterior and the right postero-lateral basals. Basals five, large, three of them pentagonal or hexagonal, the posterior

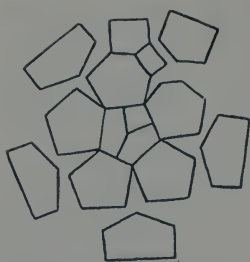


FIG. 54.—Diagram of *Lecanocrinus*.

and right postero-lateral ones having an additional side for the insertion of an anal and a radianal plate. Radials rather large, pentagonal, wider than high. Radianal plate quadrangular, placed obliquely between the posterior and right postero-lateral basals, the right posterior radial and the anal plates. Anal plate placed in line with and separating the two posterior radials, resting upon the radianal and the posterior basal. Costals one or two in each ray, very short and wide, quadrangular except the axillary ones, which are pentagonal. Distichals one to three or more in each series, varying in number even in the same individual. Interradials absent.

Arms precisely as in *Ichthyocrinus*, but less numerous.

Ventral disk unknown. Column round, composed of rather large joints.

***Lecanocrinus waukoma* (Hall), pl. xv, figs. 6-11.**

- 1865. *Lecanocrinus pusillus*. Winchell and Marcy, Mem. Bost. Soc. Nat. Hist., vol. I, p. 90. [Not *Lecanocrinus pusillus* (Hall), 1863.]
- 1868. *Cyathocrinus waukoma*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist., p. 324, pl. xi, figs. 11-12.
- 1870. *Cyathocrinus waukoma*. Hall, 20th Rep. N. Y. State Cab. Nat. Hist. (Rev. Ed.), p. 367, pl. xi, figs. 11-12.

Dorsal cup basin shaped, wider than high, varying greatly in size, the largest ones being 20 mm. in diameter; base flattened or slightly concave, the sides nearly vertical.

Infrabasals three, unequal, one small and two large ones; forming a pentagonal disk with straight sides. Basals large, about as high as wide; three of them pentagonal and two hexagonal; protuberant in the center with angular ridges radiating to the sides, the spaces between the ridges flat. Radials large, pentagonal, wider than high, the right posterior one sometimes smaller than the other four. Radianal plate of medium size, quadrangular, placed obliquely between the posterior and right postero-lateral basals below, and the right posterior radial and anal above. Anal plate about as large as the radianal, higher than wide, placed in line with the radials and resting upon the posterior basal and the radianal plates.

Costals two in each ray, very short and wide, the width being from four to five times the height; the first one quadrangular, the second pentagonal, axillary, with two long upper sloping sides supporting the two series of distichals. Number of distichals and succeeding series of brachials not determined.

Remaining portions of the species not known.

Remarks: The description of this species has been drawn up entirely from the internal casts, which are common in the Chicago fauna. But a single specimen preserving the plates has been observed, and this is a very small and presumably a young one. It is more nearly subhemispherical than the casts, and has convex plates.

The species was recognized by Winchell and Marcy from Bridgeport, and was named by them *Lecanocrinus pusillus*. It seems to be distinct from *L. pusillus* (Hall), however, from Waldron, Ind., which has priority over Winchell and Marcy's name. The Chicago species differs from the Waldron species in often growing to a much larger size, in generally having a greater relative height, and in having convex plates, unless this be a juvenile character of the only specimen in which it has been observed.

Localities—Bridgeport, Romeo, Lemont, and Joliet.

Genus 24 PYCNOSACCUS Angelin.

In general form this genus does not differ from *Lecanocrinus*, and in the internal casts as usually preserved the two genera cannot be distinguished. The plates of *Pycnosaccus* externally, however, are strongly nodose, and are ornamented by conspicuous radiating ridges which connect the nodes of adjacent plates.

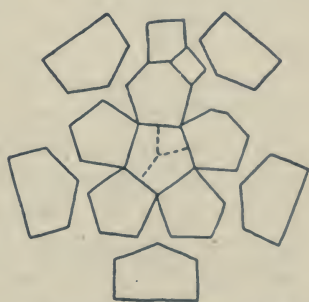


FIG. 55.—Diagram of *Pycnosaccus*.

***Pycnosaccus americanus*, n. sp., pl. xv, fig. 12.**

Dorsal cup obconical, truncate below. The plates prominent in the center with sharp, elevated ridges extending to the centers of adjacent plates; the spaces between the ridges deeply depressed.

Infrabasals large, pentagonal in a lateral view, the proximal margins extending prominently beyond the column. Ba-

sals large, higher than wide, three of them hexagonal, the posterior and right postero-lateral ones heptagonal. Radials large, wider than high. Radial plate quadrangular, the sides nearly equal, lying obliquely between the posterior and right postero-lateral basals, the right posterior radial and the anal plates. Anal plate larger than the radial, higher than wide, resting upon the truncated distal face of the posterior basal and the radial, and placed between the two posterior radials.

The remaining portions of the species unknown.

Remarks: This species is founded upon a single specimen in which a part of the plates are perfectly preserved. The genus to which it belongs was described from Gotland specimens, and heretofore it has not been recognized except in Gotland and in England.

Locality—Hawthorn.

GENERA OF UNCERTAIN AFFINITY.

Genus 25 **STEPHANOCRINUS** Conrad.

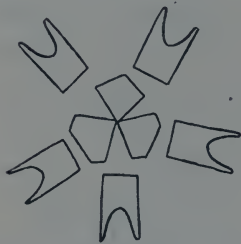


FIG. 56.—Diagram of *Stephanocrinus*.

In many respects this genus resembles certain forms of the *Blastoidea*, but it differs from them in some essential characteristics. The calyx is subpyramidal, or deeply cup shaped, with five vertical, spiniform, interradial processes surrounding the ventral disk.

Basals three, nearly equal in size but dissimilar in outline, forming a large subhemispherical or subturbinate cup, more or less truncate at the base, with a trigonal distal face which is slightly excavated for the attachment of the column; one of the plates is quadrangular, and the two others pentagonal, the quadrangular one being placed to the right of the anterior radial. The radials are large and resemble closely the forked plates of certain blastoids; the limbs (prongs of the fork) of two contiguous radials extend up between the arms in an almost vertical direction, and frequently form long, thorn-like processes which are sometimes more than one half as high as the calyx up to the arm bases. These processes form deep radial gutters containing the ambulacral grooves which lead to the arms. The costals are small, short, axillary plates, resting within a horseshoe-like depression near the outer end of the

gutter; they have three conspicuous prong-like projections extending inward. The outer ones of these projections are wing-like, resting against and partly upon the interradians; the inner one is sword-shaped, the sharp point extending deeply into the ambulacral groove dividing it and forming a branch groove for each main division of the rays.

The interradians are comparatively large and are not visible in a side view; they extend to the top of the projections and rest against the inner faces of the two limbs, the sutures running downward so as to divide each process into an inner and an outer part. The plates are connected laterally with one another, but not centrally; they leave in the center a moderately large open space which in perfect specimens is filled by oral plates. The lateral edges of the interradians are deflected, curving downward, forming a wide and deep ambulacral groove, which on approaching the inner end becomes deeper and narrower and, toward the arm bases, is divided by the costal, as described above. At each side of the ambulacral groove is a sort of depression, which forms a place of attachment for two series of small subquadrangular covering pieces which form a vault over the groove, leaving underneath a comparatively large circular passage, which at one end communicates with the arms and at the other enters the calyx beneath the edge of the oral pyramid. The anal aperture is located ventrally, near the top of one of the interradian processes, at the point where two of the limbs meet with the interradian.

The mode of branching of the arms beyond the costals is not well known, one species of the genus evidently had ten arms to the ray; they are biserial, thin, short, and pinnule-like, and do not extend beyond the interradian processes, which were apparently to protect these delicate organs.

Stephanocrinus osgoodensis S. A. M., pl. xv, fig. 14.

1879. *Stephanocrinus osgoodensis*. S. A. M., Jour. Cinn. Soc. Nat. Hist., vol. II, p. 116, pl. x, figs. 7-7a.

1891. *Stephanocrinus osgoodensis*. S. A. M., adv. sheets, 17th Rep. Geol. Surv. Ind., p. 22, pl. vi, figs. 1-4.

1892. *Stephanocrinus osgoodensis*. S. A. M., 17th Rep. Geol. Surv. Ind., p. 632, pl. vi, figs. 1-4.

This species is known in our fauna only by a few internal casts, and at best it can be but doubtfully identified. About all that can be truly said of the specimens is that they belong to the genus *Stephanocrinus*, and that their size and proportions are similar to those of *S. osgoodensis*.

The three basal plates make a pointed obconical cup, and they support the five forked radial plates which together form a short cylinder. The height of the distal points of the radials is about one half the height of the limb.

Locality—Romeo.

Genus 26 **ZOPHOCRINUS** S. A. M.

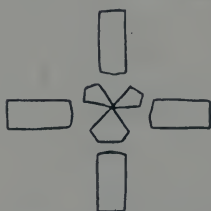


FIG. 57.—Diagram of *Zophocrinus*.

Body ovate or pear shaped, consisting of two circles of plates and the ventral disk.

Basals or first circle of plates three, forming an obconical cup, higher than wide; two of the plates are of equal size and quadrangular, the third is larger and pentagonal.

Second circle of plates four, three pentagonal and one quadrangular; they are horizontally truncated on top, and are surmounted by a ventral disk having a central elevation. The distal margins of the plates of the second circle are thickened and beveled toward the interior. The beveled edge of each plate is pierced by five pores.

The ventral disk consists of a circle of twenty minute plates, through each one of which a pore passes perpendicularly connecting with the pores that pierce the beveled edges of the plates below; within this circle of twenty plates are other smaller plates which cover the central portion of the vault.

Remarks: This genus is entirely different from any other crinoid. The pores piercing the plates are characters which would seem to ally the genus to the Cystoidea rather than the Crinoidea, and it is entirely possible that more perfect material than has yet been examined will establish its cystidian nature.

Zophocrinus howardi S. A. M., pl. xv, fig. 13.

1891. *Zophocrinus howardi*. S. A. M., Adv. Sheets 17th Rep. Geol. Surv. Ind., p. 33, pl. vi, figs. 26-28.

1892. *Zophocrinus howardi*. S. A. M., 17th Rep. Geol. Surv. Ind., p. 643, pl. vi, figs. 26-28.

Only the internal casts of this species have been observed. Calyx small, pear shaped, greatest diameter at about one half its height, pointed below, higher than wide. The plates in the casts marked by concentric grooves, which indicate lines of growth.

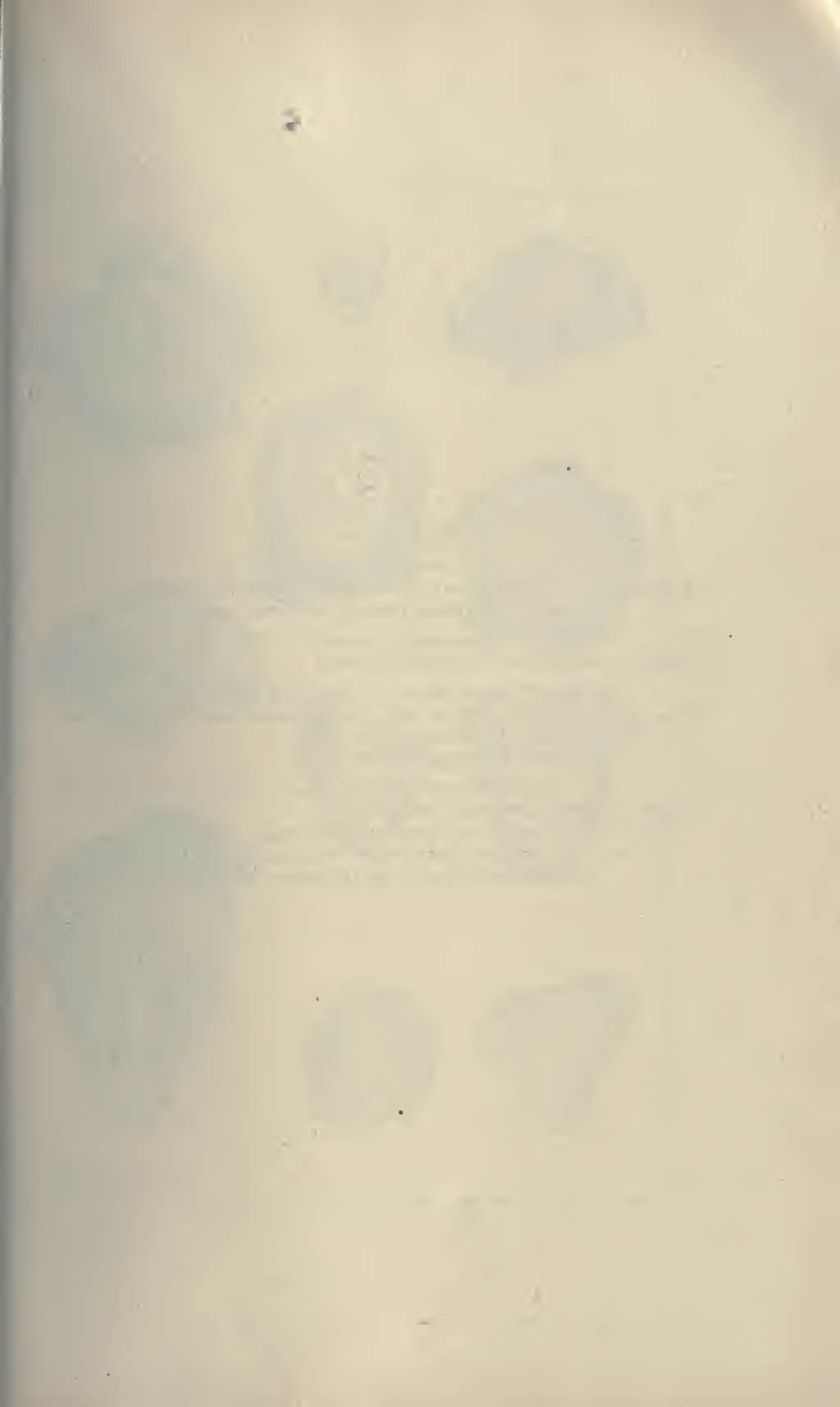
The basals or first circle of plates form an obconical cup

higher than wide, the distal faces arcuate. In the two smaller quadrangular plates the distal faces are the shorter ones; the larger pentagonal plate has distally a central, horizontal, arcuate face with two shorter sloping faces. The second circle of plates are the largest in the calyx; they are much higher than wide with subparallel sides; they expand slightly from the proximal ends and are then contracted toward the distal end, where they are horizontally truncated; in the casts there is a deep horizontal groove around the summit, the impression of the thickening of the plates at their inner distal margins.

The ventral disk not preserved.

Remarks: The genus *Zophocrinus* has hitherto been recognized only from St. Paul, Ind. The Illinois specimens differ somewhat, in general proportions, from the Indiana specimens; they are more slender and the upper part of the calyx is more nearly cylindrical. These differences are doubtless accounted for, however, in the fact that the Illinois specimens are wholly internal casts. With the plates preserved they might easily have the same form as the St. Paul specimens, and are consequently referred to the same species.

Locality—Lemont.



EXPLANATION OF PLATE I.

CYPHOCRINUS CHICAGOENSIS n. sp.

Figures 1, 2. Dorsal and lateral views of an internal cast.

" 3, 4. Lateral and ventral views of an internal cast.

THYSANOCRINUS EGANI S. A. M.

Figure 5. Lateral view of the type specimen.

THYSANOCRINUS OCCIDENTALIS Hall.

Figure 6. Lateral view of a cast taken from a natural mould, showing the surface ornamentation of the plates.

" 7. Lateral view of an internal cast.

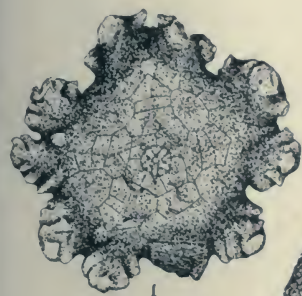
THYSANOCRINUS PENTANGULARIS Hall.

Figure 8. Lateral view of an internal cast.

" 9. Lateral view of an internal cast of a large specimen.

" 10, 11. Lateral and basal views of a cast taken from a natural mould showing the external characters of the species.

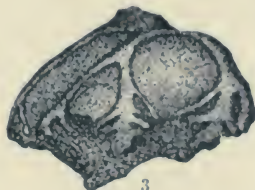
PLATE I.



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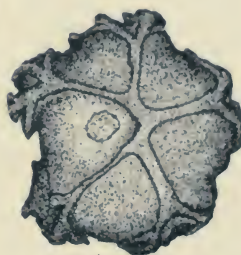
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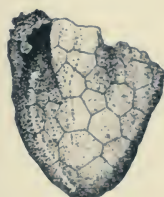
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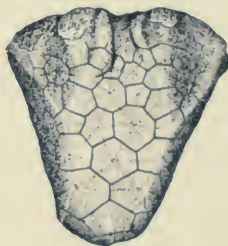
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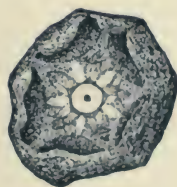
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11

Stuart Weller, del.

EXPLANATION OF PLATE II.

SIPHONOCRINUS NOBILIS Hall.

Figure 1. Lateral view of an internal cast.

LAMPTEROCRINUS INFLATUS Hall.

Figure 2. Anterior lateral view showing the casts of the pendent, tubular arms.

" 3. Lateral view of a very large internal cast.

LAMPTEROCRINUS ROBUSTUS n. sp.

Figure 4. Lateral view of a very large internal cast.

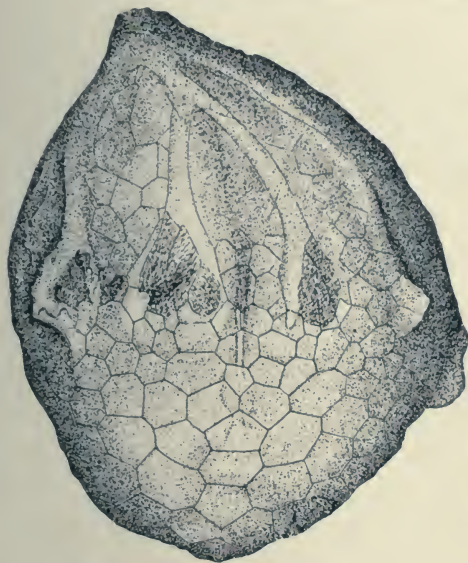
" 5. Lateral view of a wax impression from a natural mould, showing the external ornamentation of the plates.

LAMPTEROCRINUS ? DUBIUS n. sp.

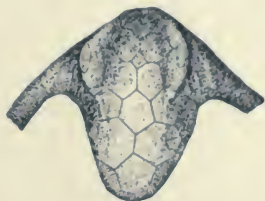
Figure 6. Lateral view of a wax impression from a natural mould, showing the external form of the calyx.

" 7. Lateral view of an internal cast showing the cast of the proboscis.

PLATE II.



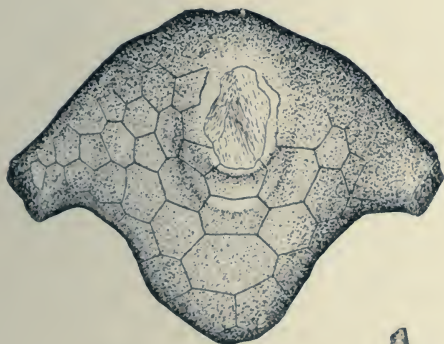
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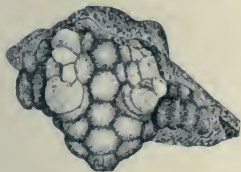
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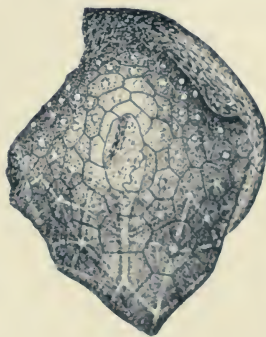
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EXPLANATION OF PLATE III.

GAZACRINUS MAJOR n. sp.

Figure 1. Posterior view of an internal cast.

" 2. Lateral view of a specimen preserving the plates.

GAZACRINUS MINOR n. sp.

Figure 3. Lateral view of a large internal cast.

" 4. Posterior view of an internal cast.

LAMPTEROCRINUS ? SUBGLOBOSUS n. sp.

Figure 5. Lateral view of an internal cast.

LYRIOCRINUS MELISSA Hall.

Figure 6. Basal view of a small specimen.

" 7, 8. Basal and lateral views of a large specimen.

ARCHÆOCRINUS DEPRESSUS n. sp.

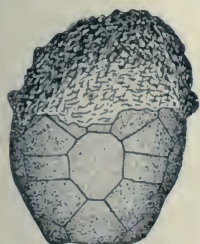
Figures 9, 10. Lateral and basal views of an internal cast.

MELOCRINUS OBPYRAMIDALIS W. and M.

Figure 11. Lateral view of an internal cast.

" 12. Lateral view of a wax impression from a natural mould, showing the external characters of the species.

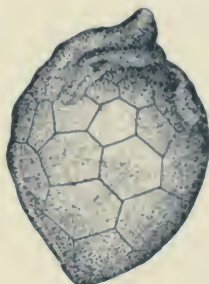
PLATE III.



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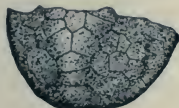
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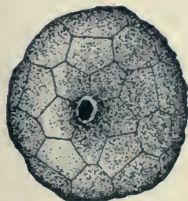
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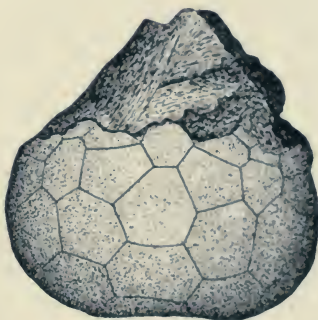
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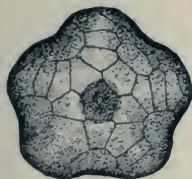
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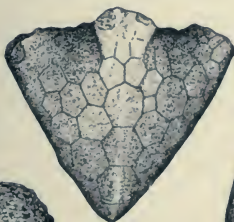
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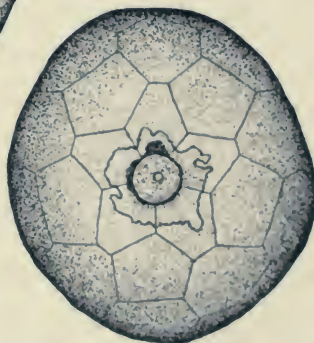
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Stuart Weller, del.

EXPLANATION OF PLATE IV.

CORYMBOCRINUS CHICAGOENSIS n. sp.

- Figure 1. A large internal cast preserving the outlines of most of the plates of the dorsal cup.
" 2. Basal view of an internal cast showing the broad basal cavity.
" 3. Lateral view of a specimen preserving the plates.

CORYMBOCRINUS NIAGARENSIS n. sp.

- Figures 4, 5. Basal and lateral view of the type specimen.

MACROSTYLOCRINUS OBCONICUS n. sp.

- Figure 6. Lateral view of an internal cast.
" 7. Lateral view of a wax impression taken from the natural mould of the same specimen.

MACROSTYLOCRINUS SUBGLOBOSUS n. sp.

- Figure 8. Lateral view of an internal cast.

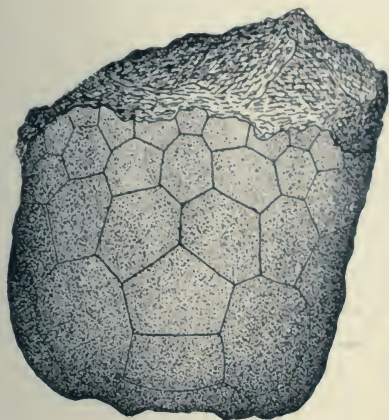
MACROSTYLOCRINUS SEMIRADIATUS Hall.

- Figure 9. Lateral view of an internal cast.

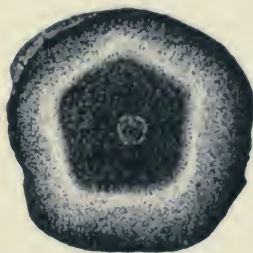
MACROSTYLOCRINUS STRIATUS Hall.

- Figure 10. Lateral view of an internal cast.
" 11. Lateral view of a specimen preserving the plates.

PLATE IV.



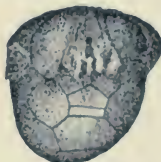
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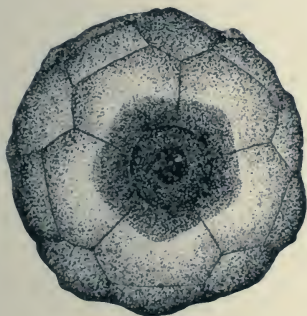
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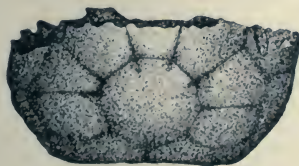
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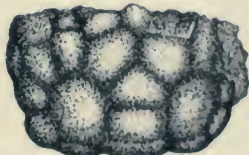
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Stuart Weller, del.

EXPLANATION OF PLATE V.

EUCALYPTOCRINUS CRASSUS Hall.

Figure 1. Lateral view of a cast, showing the impressions of the arms.

" 2. Lateral view of a small internal cast.

EUCALYPTOCRINUS ROTUNDUS S. A. M.

Figure 3. Lateral view of the type specimen.

EUCALYPTOCRINUS ASPER n. sp.

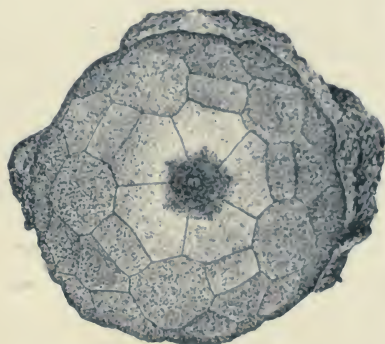
Figures 4, 5. Lateral and basal views of an internal cast of a dorsal cup.

" 6, 7. Lateral and basal views of the type specimen preserving the plates.

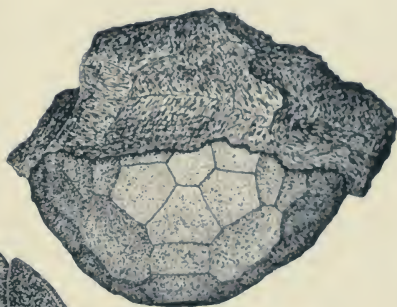
PLATE V.



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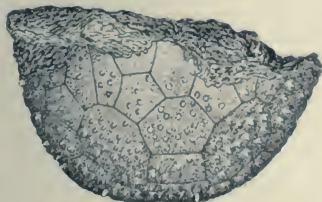
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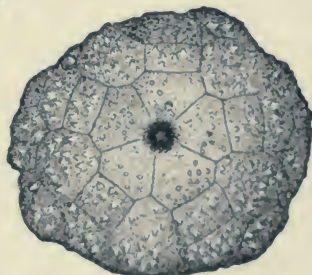
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Stuart Weller, del.

EXPLANATION OF PLATE VI.

EUCALYPTOCRINUS TURBINATUS S. A. M.

Figure 1. Lateral view of one of the type specimens.

" 2. Basal view of the other type specimen. Both specimens are internal casts.

EUCALYPTOCRINUS INORNATUS n. sp.

Figures 3, 4. Basal and lateral views of the type specimen preserving the plates.

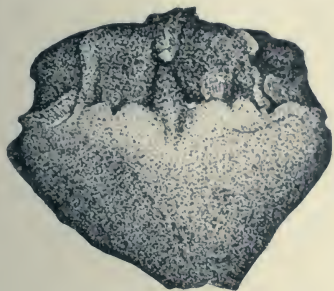
EUCALYPTOCRINUS ORNATUS Hall.

Figures 5, 6. Lateral and basal views of a specimen preserving the plates.

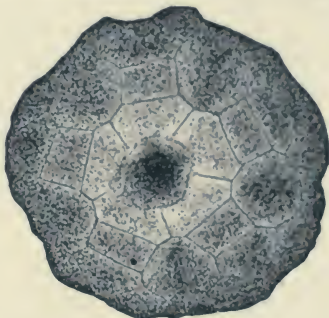
EUCALYPTOCRINUS MAGNUS Worthen (?)

Figure 7. Basal view of an internal cast possibly belonging to this species.

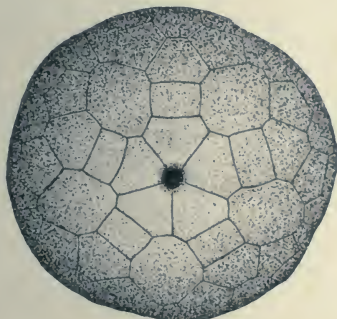
PLATE VI.



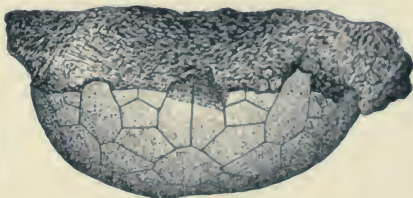
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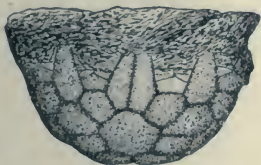
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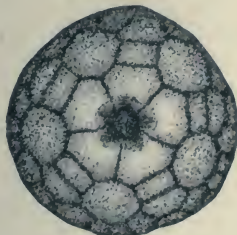
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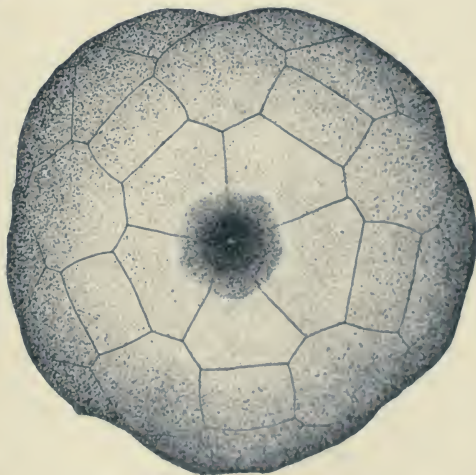
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EXPLANATION OF PLATE VII.

EUCALYPTOCRINUS NODULOSUS n. sp.

Figure 1. Lateral view of an internal cast.

" 2, 3. Basal and lateral views of a wax cast from a natural mould.

EUCALYPTOCRINUS EGANI S. A. M.

Figure 4. Lateral view of an internal cast.

EUCALYPTOCRINUS DEPRESSUS S. A. M.

Figures 5, 6. Lateral and basal views of a specimen preserving the plates.

" 7. Basal view of an internal cast. One of the type specimens.

EUCALYPTOCRINUS OBCONICUS Hall.

Figure 8. Lateral view of an internal cast. (After Hall.)

CHICAGOCRINUS ORNATUS n. sp.

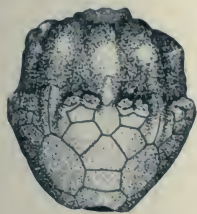
Figure 9. Lateral view of a wax cast from a natural mould. The type specimen.

CHICAGOCRINUS INORNATUS n. sp.

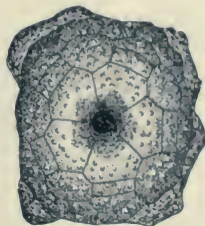
Figure 10. Lateral view of an internal cast.

" 11, 12. Basal and lateral views of a wax cast from a natural mould.
Same individual as figure 10.

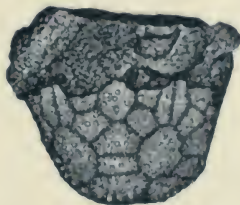
PLATE VII.



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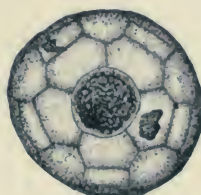
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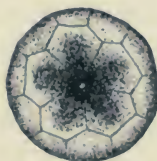
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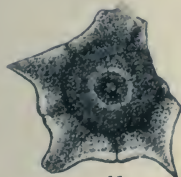
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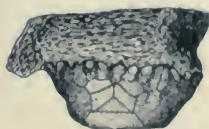
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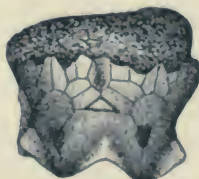
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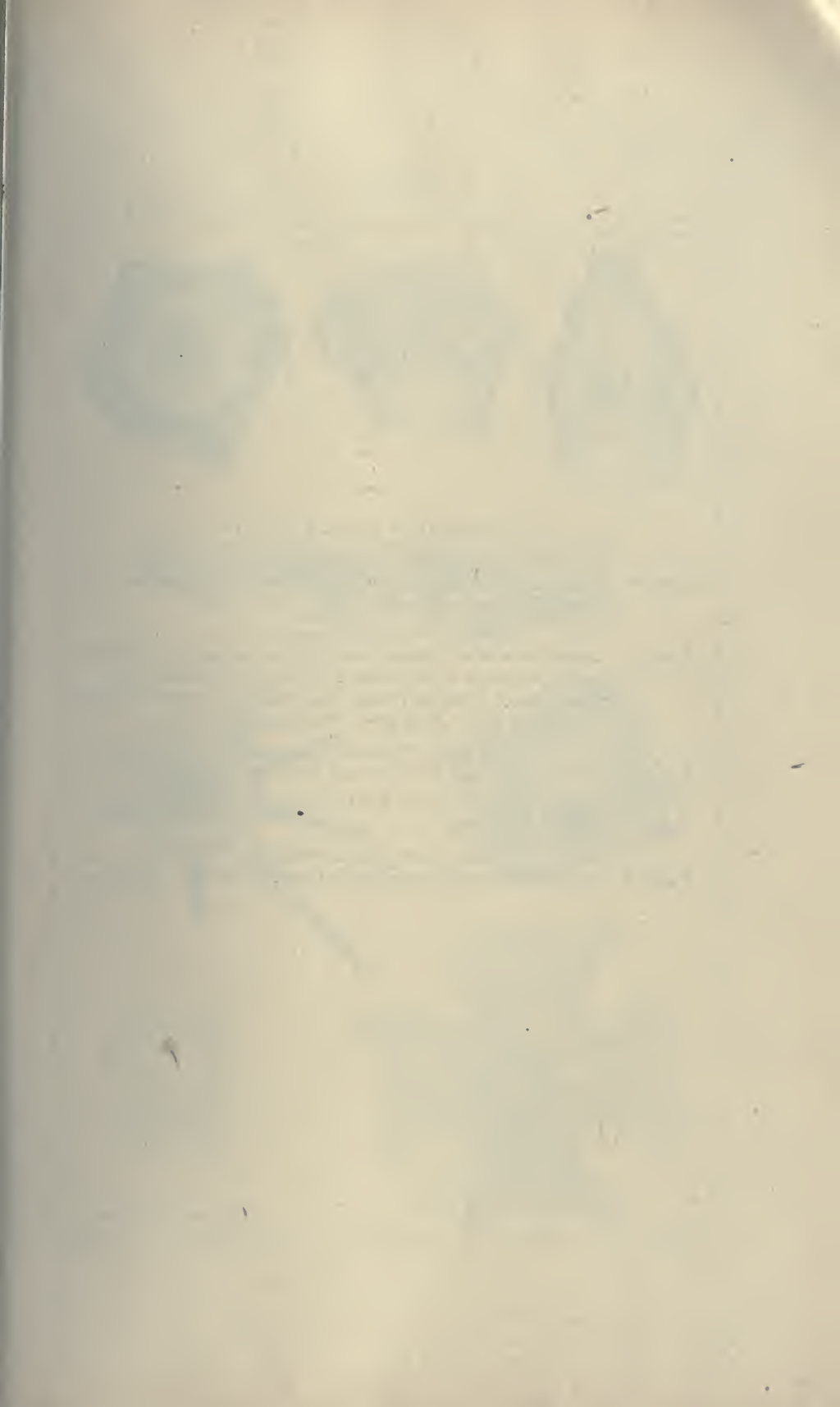
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EXPLANATION OF PLATE VIII.

CALLICRINUS CORNUTUS Hall.

Figures 1, 2. Basal and lateral views of the internal cast of a dorsal cup.

" 3. Lateral view of an internal cast.

CALLICRINUS LONGISPINUS n. sp.

Figure 4. Lateral view of an internal cast with the impressions of the spinose extensions of the radial and first interbrachial plates.

" 5. Basal view of a wax cast taken from the same individual, showing the spinose extensions of the plates.

CALLICRINUS PENTANGULARIS n. sp.

Figure 6. View of a wax cast from the type specimen.

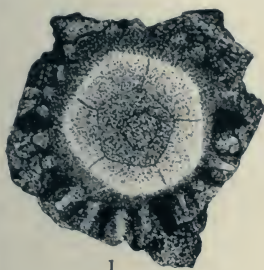
CALLICRINUS BIFURCATUS n. sp.

Figure 7. The type specimen.

CALLICRINUS HYDEI Weller.

Figure 8. An impression of the terminal anal disk. The type specimen.

PLATE VIII.



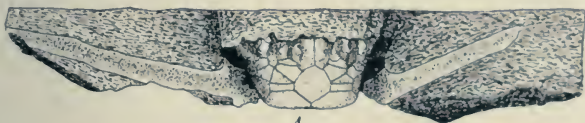
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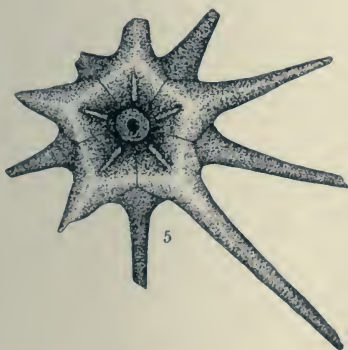
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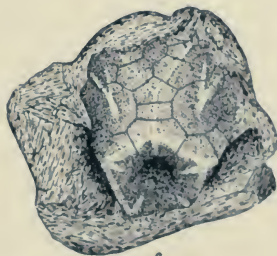
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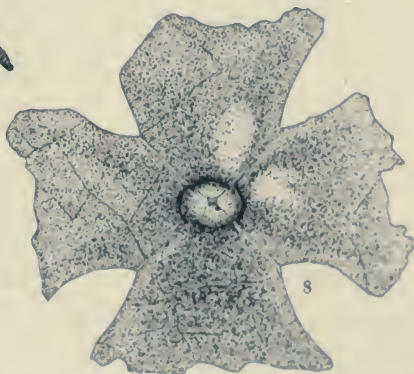
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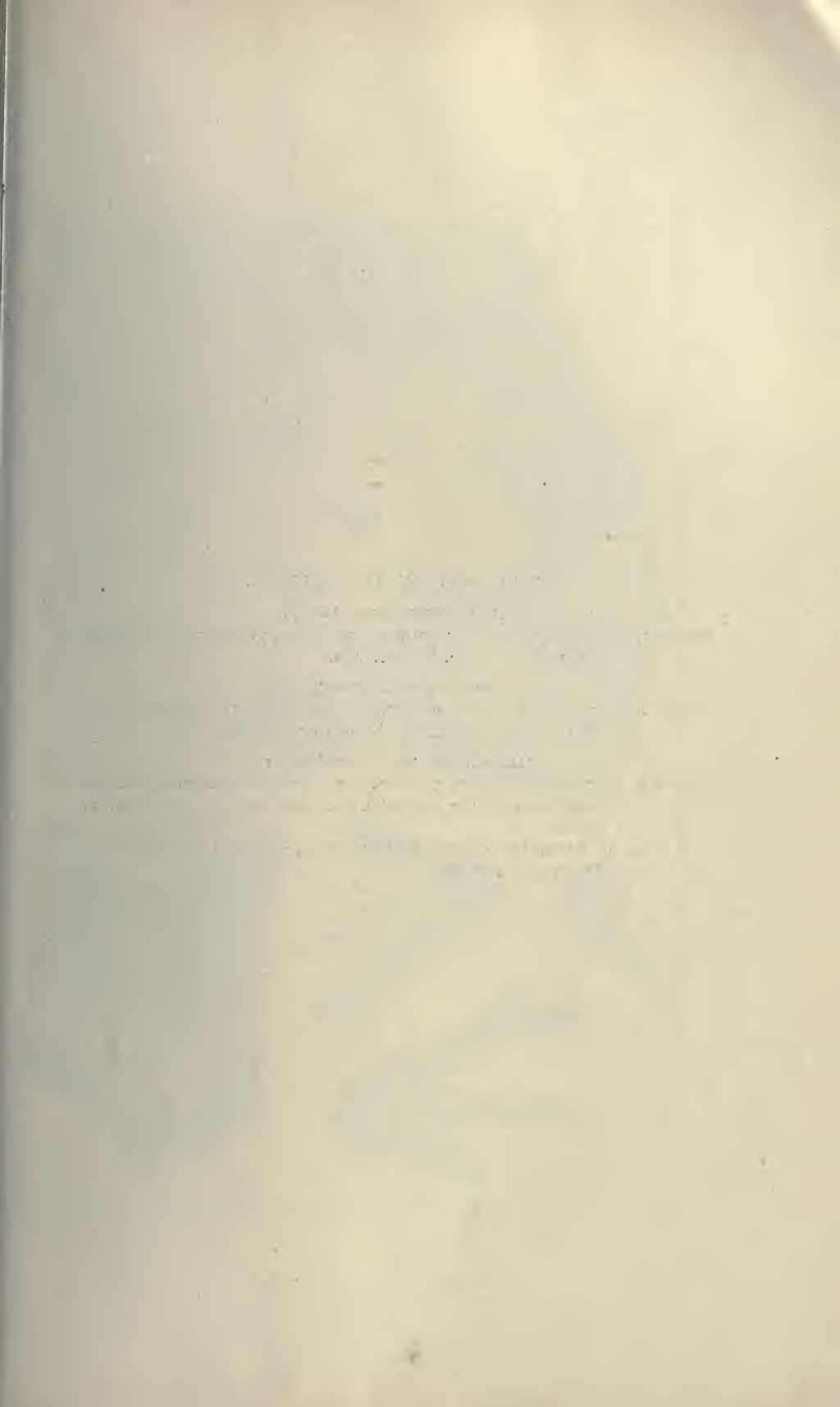


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Stuart Weller, del.



EXPLANATION OF PLATE IX.

CALLICRINUS HYDEI Weller.

Figure 1. An impression of the terminal anal disk, probably belonging to this species. From Racine, Wis.

CALLICRINUS DESIDERATUS n. sp.

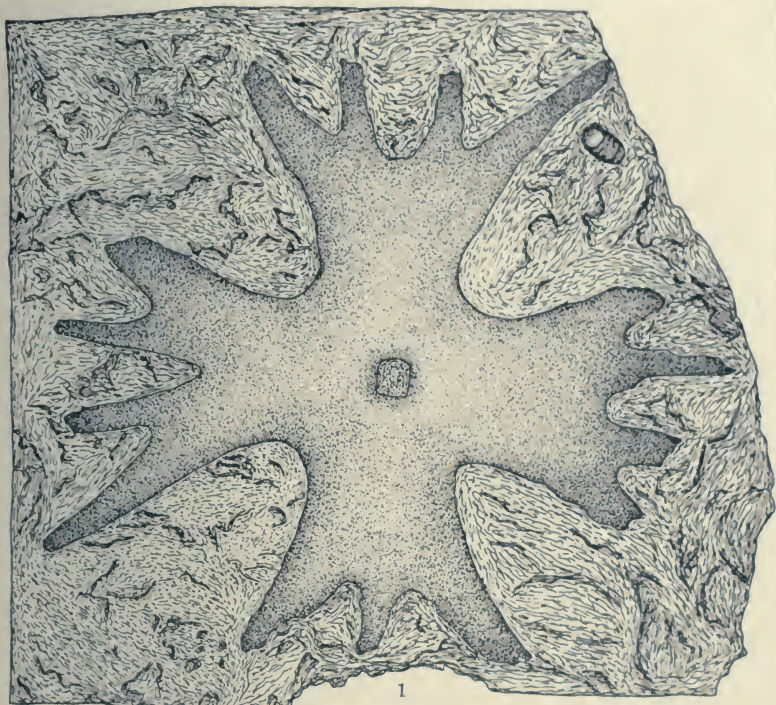
Figure 2. View of a specimen in which the terminal disk is in position at the end of the anal tube. From Racine, Wis.

CALLICRINUS DIGITATUS Weller.

Figure 3. A specimen showing parts of the impressions of two of the terminal plates of the anal tube. Perhaps belonging to a distinct species.

" 4. An impression of one of the terminal plates of the anal tube. The type specimen.

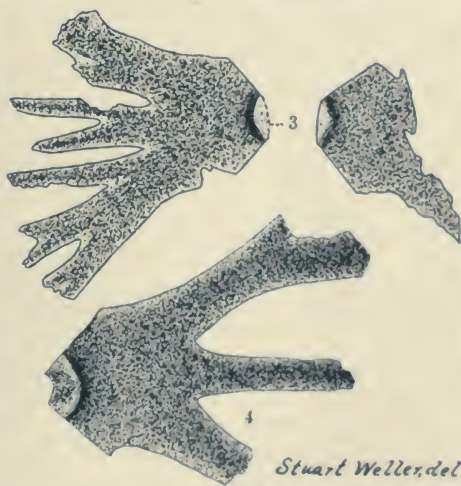
PLATE IX.



1



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EXPLANATION OF PLATE X.

CALLICRINUS HYDEI Weller.

Figure 1. An impression of the terminal anal disk. The reverse of the specimen illustrated on plate ix, figure 1.

" 2. Impression of a small terminal disk plate.

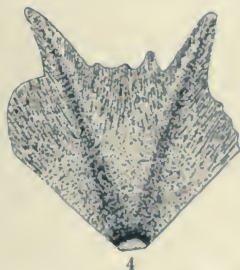
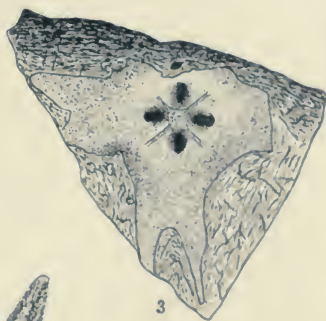
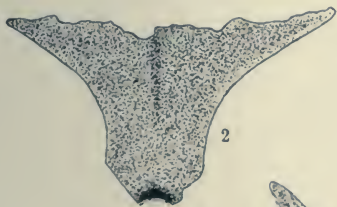
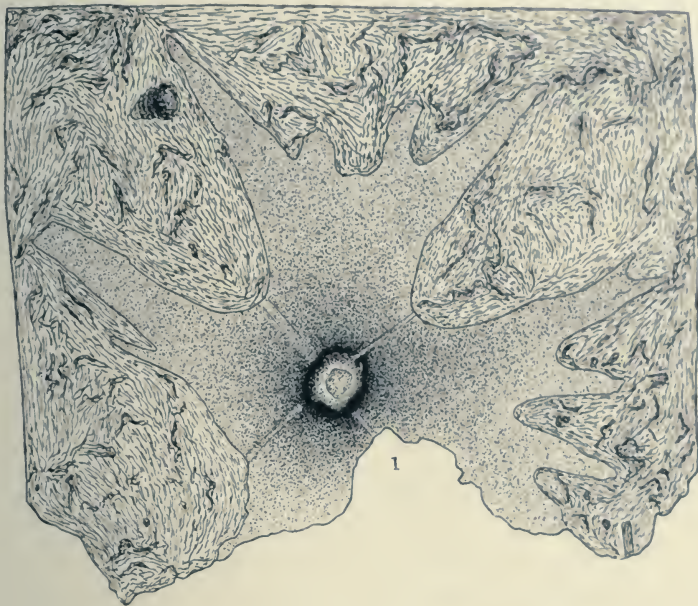
CALLICRINUS DESIDERATUS n. sp.

Figure 3. An impression of a terminal anal disk showing the impressions of the four spines which surround the anal opening.

CALLICRINUS BILOBUS Weller.

Figure 4. The impression of one terminal plate of the anal tube. The type specimen.

PLATE X.



Stuart Weller, del.

EXPLANATION OF PLATE XI.

CALLICRINUS DESIDERATUS n. sp.

Figures 1, 2. Two lateral views of an internal cast of the anal tube.

" 3. Diagrammatic lateral view of the anal tube, with the terminal anal disk.

" 4. Diagrammatic lateral view of *C. costatus* His., for comparison with the last.

CALLICRINUS DIGITATUS Weller.

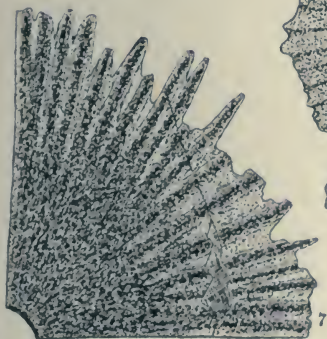
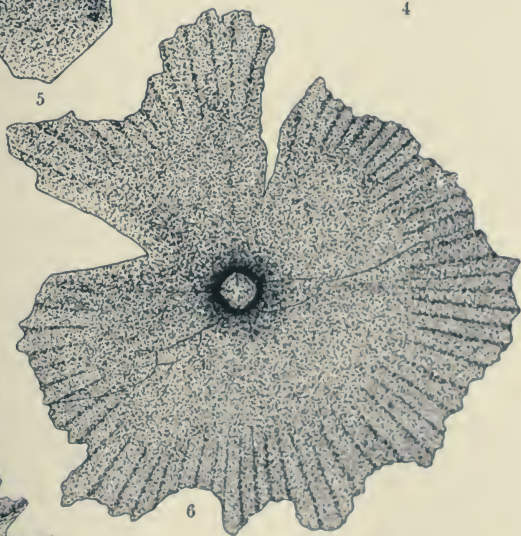
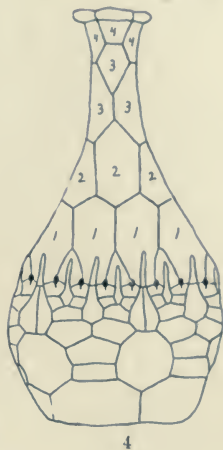
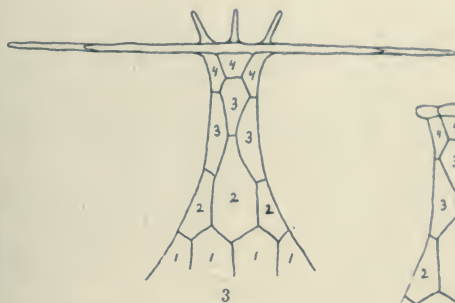
Figure 5. The reverse of the specimen illustrated on plate ix, figure 4.

CALLICRINUS CORRUGATUS Weller.

Figure 6. An impression of a complete terminal disk.

" 7. Impression of a single plate of the terminal anal disk.

PLATE XI.



Stuart Weller, del.

EXPLANATION OF PLATE XII.

PERIECHOCRINUS URNIFORMIS S. A. M.

Figure 1. Lateral view of an internal cast. The specimen is somewhat crushed so that the ventral disk appears more convex than normal.

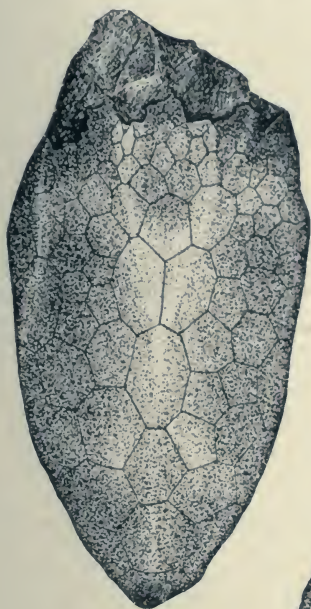
PERIECHOCRINUS MARCOUANUS W. and M.

Figure 2. Lateral view of a specimen preserving the plates.

" 3. Lateral view of an internal cast.

" 4. Lateral view of a very large internal cast.

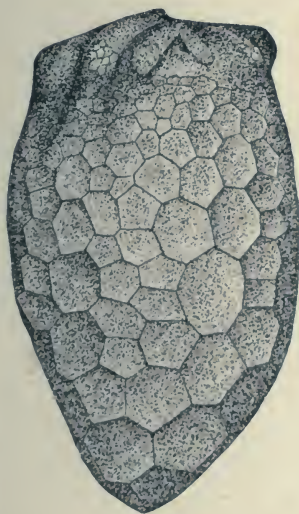
PLATE XII.



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S. Waller del

EXPLANATION OF PLATE XIII.

PERIECHOCRINUS INFELIX W. and J. M.

Figure 1. Lateral view of an internal cast.

" 2. View of an internal cast of the tegmen.

PERIECHOCRINUS URNIFORMIS S. A. M.

Figure 3. Lateral view of a large internal cast.

" 4. View of an internal cast of the tegmen.

PERIECHOCRINUS NECIS W. and M.

Figure 5. Lateral view of a slender internal cast.

" 6. Lateral view of a very broad internal cast.

PERIECHOCRINUS CHICAGOENSIS n. sp.

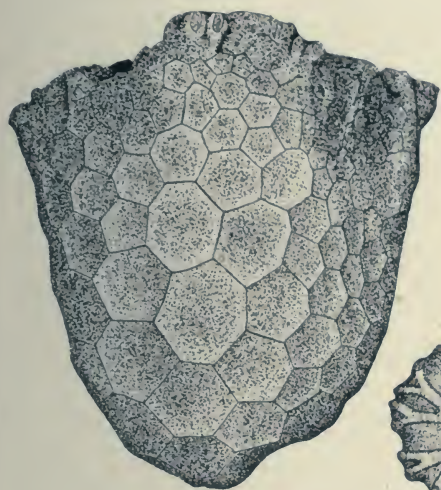
Figure 7. Lateral view of an internal cast, posterior side.

" 8. Lateral view of another internal cast.

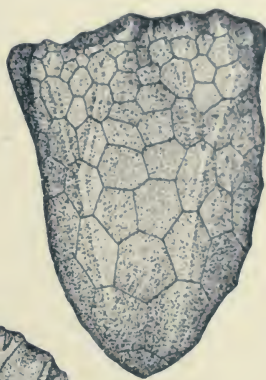
PERIECHOCRINUS EGANI S. A. M.

Figure 9. Lateral view of the type specimen preserving the plates.

PLATE XIII.



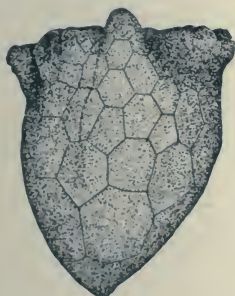
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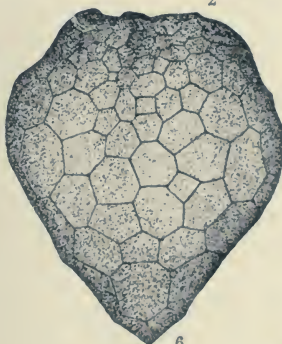
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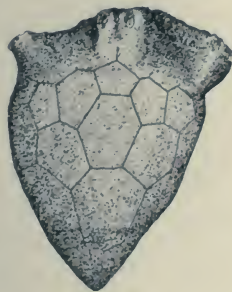
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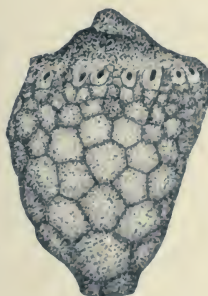
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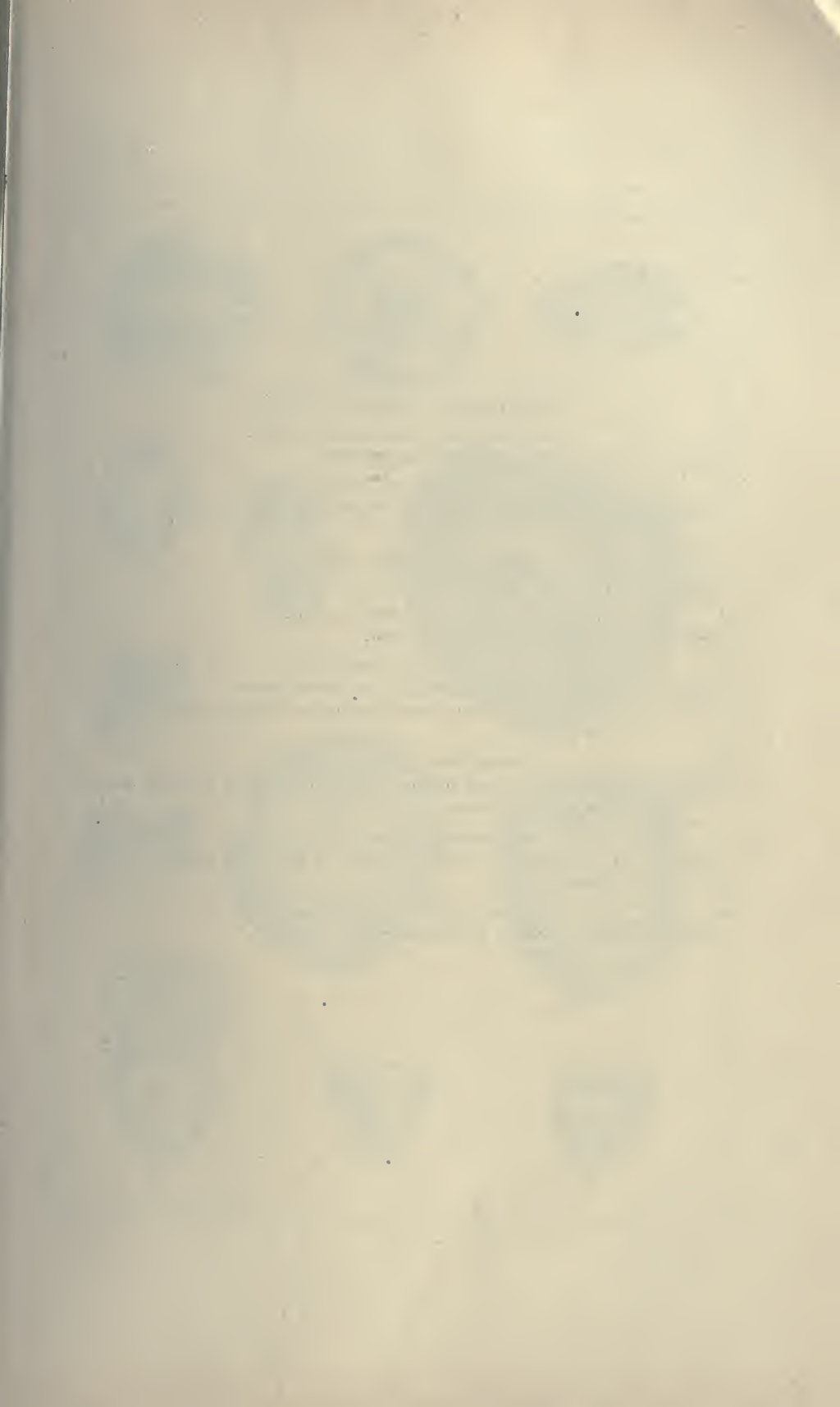


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Stuart Weller, del.



EXPLANATION OF PLATE XIV.

CROTALOCRINUS AMERICANUS n. sp.

Figure 1. Wax impression of the type specimen.

MARSUPIOCRINUS CHICAGOENSIS n. sp.

Figures 2, 3. Basal and lateral views of the type specimen, preserving the plates.

PLATYCRINUS (?) DUBIUS n. sp.

Figure 4. Lateral view of an internal cast.

CYATHOCRINUS VANHORNII S. A. M.

Figure 5. Lateral view of an internal cast.

CYATHOCRINUS CORA Hall.

Figures 6, 7, 8. Lateral views of three large internal casts.

" 9, 10. Two radial plates from another specimen, preserving casts of the arms.

AMPHERISTOCRINUS DUBIUS n. sp.

Figure 11. Lateral view of an internal cast from the right posterior side. The type specimen.

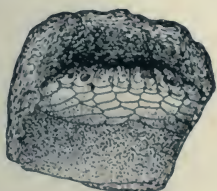
BOTRYOCRINUS POLYXO Hall.

Figure 12. A right posterior lateral view of a specimen preserving the plates.

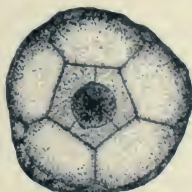
CYATHOCRINUS TURBINATUS n. sp.

Figure 13. Lateral view of an internal cast.

PLATE XIV.



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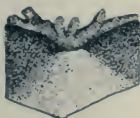
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Stuart Weller, del.

EXPLANATION OF PLATE XV.

MYELODACTYLUS BRIDGEPORTENSIS S. A. M.

Figures 1, 2. Views of two of the type specimens.

ICHTHYOCRINUS SUBANGULARIS Hall.

Figure 3. A small specimen preserving the plates.

" 4. A large specimen preserving the plates. (After Hall.)

" 5. Lateral view of a very large internal cast.

LECANOCRINUS WAUKOMA Hall.

Figure 6. Posterior lateral view of a large internal cast.

" 7. Posterior lateral view of a small, much depressed internal cast.

" 8, 9, 10. Two lateral views and one basal view of an internal cast.

" 11. A small specimen preserving the plates.

PYCNOSACCUS ORNATUS Weller.

Figure 12. Posterior lateral view of a specimen partially preserving the plates.

ZOPHOCRINUS HOWARDI S. A. M.

Figure 13. Lateral view of an internal cast.

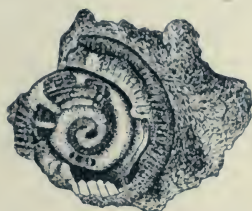
STEPHANOCRINUS OSGOODENSIS S. A. M.

Figure 14. Lateral view of an internal cast.

PLATE XV.



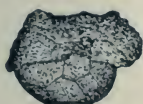
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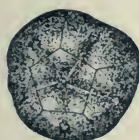
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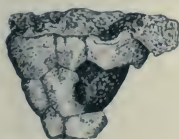
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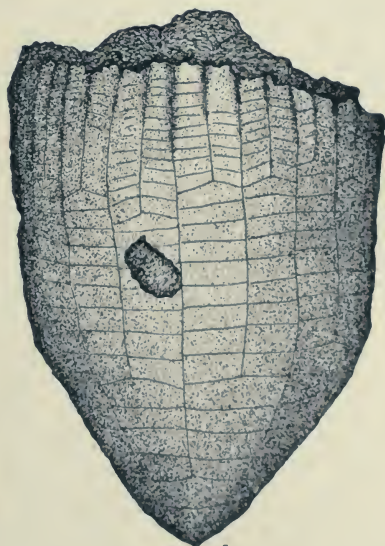
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